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LATERAL TRANSLATION OF EXPLOSION CRATER EJECTA: A WORKING MODEL BASED UPON PELLET EXPERIMENTS

Mark Settle

Air Force Cambridge Research Laboratories Hanscom Air Force Base, Massachusetts

19 August 1975

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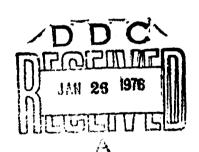
Lateral Translation of Explosion Crater Ejecta: A Working Model Based Upon Pellet Experiments

MARK SETTLE, 1/LT, USAF

19 August 1975

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SECURITY CLASSIFICATION OF THIS PAGE (When Date Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM		
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AFCRL-TR-75-0453			
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CRATER EJECTA: A WORKING MODEL	Scientific. Interim.		
BASED UPON PELLET EXPERIMENTS	ERP, No. 528		
7. AUTHOR(e)	8. CONTRACT OR GRANT NUMBER(*)		
Mark Settle, 1 Lt, USAF			
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT PROJECT, TASK		
Air Force Cambridge Research Laboratories (LWV	86070501		
Hanscom AFB Massachusetts 01731	61102F		
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE		
Air Force Cambridge Research Laboratories (LWV			
Hanscom AFB	13. HUMBER OF PAGES		
Massachusetts 01731	669		
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approximately comparable to the coarsest fraction of naturally occurring unconsolidated surficial materials (for example, playa and alluvium). A comparison of pellet throwout ranges with the translation of dyed sand and other artificial tracers in smaller and larger scale explosion experiments supports the analogy between the pellets employed here and the coarser size fraction of unconsolidated earth media.

The postshot range r of a mass point ejected by an explosive cratering event can be related to its preshot range x (measured from surface ground zero) by a power-law expression of the form: $(r/R) \alpha (x/R)^c$, where absolute ranges x and r are normalized to R, the crater radius. Lateral (radial) translation of the artificial pellets ejected from the upper portions of the explosion craters could be approximately characterized by this expression with $c \cong -4.0 \pm 1.0$. In comparison, translation of the bulk of the ejecta excavated by larger explosion cratering experiments (for example, Stagecoach, Air Vent I) and smaller laboratory scale experiments (conducted at the University of Dayton Research Institute) in relatively unconsolidated earth media is characterized by the power law expression with $c \cong -2.5 \pm 1.0$. This relationship describing the lateral translation of the bulk of the ejecta is observed over a wide range of charge size and crater shape.

The lateral translation of the coarsest fraction of explosion crater ejecta initially situated near the original ground surface exceeds the average translation ranges of smaller particle sizes and thus poses the most severe natural missile hazard to personnel and surface facilities. The variation of the exponent c with depth within the crater of excavation for a series of experiments at various scaled depths of burst can be employed as an empirical model of the translation of the coarsest ejecta size fraction for larger scale explosion events.

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Preface

Field assistance was provided by R. Dowling, D. Pendleton, SSgt R. Sands, and MSgt R. Tarnawa. The author is grateful for frequent discussions with S. Needleman. The coherence of the manuscript was improved considerably by the helpful comments of J.W. Head. The patience and effort of Cathy Dion in preparation of the manuscript is also appreciated.

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Lateral Translation of Explosion Crater Ejecta: A Working Model Based Upon Pellet Experiments

1. INTRODUCTION

The ability to characterize the spatial and temporal distribution of ejecta produced by an explosive cratering event is essential to the development of accurate siting criteria for surface and near surface weapons systems and various support facilities (for example, detection and communication facilities). Empirical studies of block size distributions around explosion craters ¹⁻³ together with ballistic models of ejection conditions ^{4,5} result in a partial, largely statistical description of the actual ejecta environment. ⁶ The ability to relate the process of ejecta deposition to the mechanics of excavation controlling the formation of the crater would cortribute significantly to (1) developing a framework for extrapolating empirical ejecta studies to a variety of yields and geological settings, and (2) characterizing the relative threat the total ejecta environment poses to ground based facilities and personnel.

Similarly, the sampling goals of the recent Apollo missions have led to an intensive study of the impact cratering process, 7^{-11} . Current theories describing the cratering of impact crater formation are based primarily upon (1) small scale impact experiments performed over a limited range of impact velocity, projectile size, and with idealized target materials, and (2) field relationships observed at

(Received for publication 19 August 1975)

^{*}Duc to the large number of references in above text, please refer to Reference Page No. 45 for references 1 through 11.

large terrestrial impact craters that have been preserved at various erosional levels. An impact cratering event in a layered target produces a stratified ejecta deposit with stratigraphy which is approximately inverted with respect to the local pre-existing layering, with deepest material deposited near the crater rin: and successively shallower horizons extending to successively greater radial ranges. Geometrical models of ejecta distribution 10, 12 and secondary cratering effects 13, 14 have suggested that variations in the amount of primary ejecta and the velocity at which it impacts the original ground surface are responsible for the morphology of ejecta deposits observed over a range of impact crater size. 11, 15, 16 The variety of morphologies associated with impact crater ejecta deposits primarily reflects the range of particle velocity associated with the lateral translation of primary ejecta from the crater of excavation to a specific radial range. Generally, material thrown farther travels faster so that the total ejecta deposit can reflect a variety of depositional processes ranging from the low velocity overturning of massive sections of target material up onto the crater rim to a region of discontinuous secondary cratering at greater ranges (see Oberbeck, 1975), 11

In comparison, the ejecta deposit produced by an explosive cratering event has qualitatively similar features: the deepest material excavated appears on or near the rim, and the ejecta deposit is thickest at the crater rim crest and thins rapidly at larger radial ranges. Oberbeck ¹⁷ has demonstrated dimensional similarities in crater shape and ejecta plume formation, and dynamic similarities in the radial attenuation of shock pressures for experimental impact and near-surface explosive cratering events. These similarities are observed for explosion craters with scaled depths of burst (SDOB) in the range 0, 10 to 0, 50 ft/(lb TNT)^{1/3}. This analogy between impact and near-surface explosion cratering may extend to much

^{12.} McCetchin, T.R., Settle, M., and Head, J.W. (1973a) Radial thickness variation in impact crater ejecta: Implications for lunar basin deposits, Earth Planetary Sci. Lettr. 20:226-236.

^{13.} Oberbeck, V.R., Morrison, R.H., Horz, F., Quaide, W.L., and Guult, D.E. (1974) Smooth Plains and Continuous Deposits of Craters and Basins, NASA Tech Main N-62, 376, Ames Research Center, Molfett Field, California.

^{14.} Oberbeck, V.R., Horz, F., Morrison, R.H., and Quaide, W.L. (1973)

Emplacement of the Cayley Pormation, NASA Tech Mem X-62, 302, Ames Research Center, Moffett Field, California.

Morrison, R. H., and Oberbeck, V. R. (1975) Features of crater continuous deposits and interpretations of their origin, Lunar Science VI, p. 578-580, The Lunar Science Institute, Houston, Texas.

Settle, M., and Head, J.W. (1975) Topographic variations in lunar crater rim profiles: Implications for the formation of ejecta deposits, submitted to learns.

^{17.} Oberbeck, V.R. (1971) Laboratory simulation of impact cratering with high explosives, Jour. Geophys. Res. 76:5732-5749.

larger craters. ¹⁸ Thus, the variety of depositional processes which characterize large impact craters may also be produced by correspondingly large, near-surface explosive events. In fact, an annular zone of secondary craters was produced by the Sedan explosion, a large nuclear explosion in alluvium. ¹⁹

1.1 Purpose of the Present Study

A complete characterization of the mechanics of ejecta deposition should include a description of ejection velocity, ejection angle, particle size distribution, and postshock strength of material excavated by an individual cratering event. These ejection parameters are primarily determined by the response of the specific material to the stress wave generated by both explosive and impact events and by the acceleration of gases produced in the explosion case. The postshock strength of the material, ejecta particle size distributions, and ejection parameters generally reflect the relative intensity of the stress wave at different distances from the center of the crater. The subsequent excavation stage of the crater formation process then redistributes these stress-induced variations by translating material to a variety of ranges. The distribution and morphology of the resulting ejecta deposit represent a transformed record of excavation para—ters within the transient crater of excavation during the cratering event.

The purpose of the present study is to empirically characterize the 'transformation function' by which the excavation phase of an explosive cratering event translates material from a pre-event position to a post-event range within the ejecta deposit. The relationship between the original and final position of ejected material places important constraints on the distribution of shock stress and kinetic energy produced within the test medium by the explosion. This, in turn, permits the association of observed ejecta morphologies such as the hummocky and grooved terrain observed within the continuous ejecta deposit, ejecta rays, and discontinuous ejecta clusters with the relative levels of energy distribution within the test medium.

The explosion cratering experiments described in this report were designed to empirically describe the material translation process. Tracer pellets were emplaced at specific positions within the test medium prior to a shot, then these pellets were located and their final positions were surveyed after the shot. Lateral pellet translation refers to the radial displacement of a pellet produced by the explosive cratering event measured from surface ground zero (SGZ). All experiments

^{18.} Baldwin, R.B. (1963) The Measure of the Moon, The University of Chicago Press, Chicago, Illinois.

^{19.} Roberts, W.A. (1985) Permanent angular displacement and ejecta-induced impulse associated with crater formation, <u>learus</u> 4:480-493.

were conducted at SDOB in the range appropriate to the impact crater analogy. Thus, the results of the present study can be directly compared with small impact cratering experiments.

2. THE EXPERIMENTS: SETTING, MATERIALS, AND PROCEDURE

Small scale explosive cratering experiments were conducted within the Ft. Devens Reservation during the period of September 1973 through September 1974. The pellet experiments described in this report represent a part of the total research program accomplished during this period. The results of parallel studies concerning the effects of explosive cratering on the bearing strength of granular earth materials will be reported elsewhere (see Settle and Needleman (1974) for preliminary results 20).

2.1 Test Site

All cratering experiments were performed in an area approximately 50 m × 75 m within the Hotel Range on the Ft. Devens Reservation (see Figure 1). The bedrock geology of the area consists of a metamorphosed sequence of carboniferous sedimentary units situated within the Worcester trough. In the vicinity of the test site, this sequence is represented by phyllite, schist, and quartzite rocks which are extensively intruded by granite and minor amounts of diabase. The surface geology surrounding the site is dominated by glacial deposits of variable thickness.

Hotel Range in particular is an area of substantial fill, consisting mostly of quartz sand with minor amounts (<3 percent) of feldspar and mica also present. Seismic investigation of the subsurface structure of the site has revealed that the deposit of fill extends to a depth of approximately 2 to 3 m and has an acoustic velocity of 1000 m/sec. The fill rests upon much coarser material which appears to be a deposit of glacial till (S. Needleman, personal communication).

The edges of Hotel Range are generally overgrown with bushes and saplings while the periphery of the actual test site is consolidated primarily by grasses and mosses (see Figure 1). The range of particle size distributions of the

Settle, M., and Needleman, S. (1974) Deformation in granular earth media produced by explosive cratering: Implications for impact cratering, EOS <u>Transactions Am. Geophys. Union</u> 56, No. 12:1142.

^{21.} Emerson, B.K. (1917) Geology of Massachusetts and Rhode Island, U.S. Geological Survey Bull. No. 597, 289 pp.

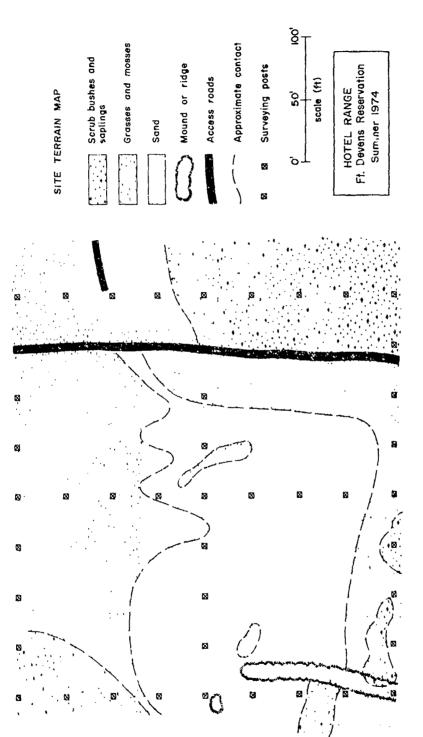


Figure 1. Sketch Map of Hotel Range on the Fort Devens Reservation. Explosion experiments reported in this paper were conducted within the sand fill area

unconsolidated quartz sand fill near the surface of the test site is shown in Figure 2. Generally 10 percent of the surface material is coarser than 1 mm while approximately 50 percent of the surface material is finer than 0.5 mm. Repeated precipitation in areas of fill will commonly wash finer material from the near surface portion of the fill deposit and redeposit this finer material at greater lepth. Such an effect has been observed at the Boeing Company Tulalip test site. Indeed, grain size analysis of subsurface samples reveals that a shallow ledge of finer, clay-like material exists approximately 0.5 m beneath the western side of the test site. This is consistent with the drainage of the area: the test site dips gently to the south southwest by 3° to 5°.

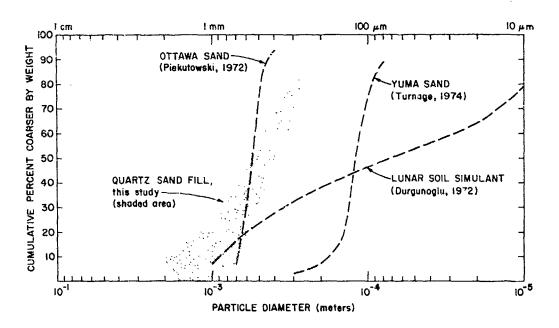


Figure 2. Particle Size Distribution of the Quartz Sand Fill at Ho 1 Range, Ft. Devens. Other sands and soil types are shown for comparison 22,...3

^{22.} Durgunoglu, H.T. (1972) Static Penetration Resistance of Soils, PhD Thesis, University of California, Berkeley, California.

^{23.} Turnage, G.W. (1974) Measuring Soil Properties in Vehicle Mobility Research;
Resistance of Coarse Grained Soils to High Speed Penetration, Tech. Rpt
No. 3-652, Report 6, U.S. Army Waterways Experiment Station, Mobility
and Environmental Systems Lab., Vicksburg, Mississippi.

^{24.} Fulmer, C.V. (1965) Cratering Characteristics of Wet and Dry Sand, The Boeing Company Report D2-90683-1, Seattle, Washington.

2.2 Materials

The pellets used in these experiments were spheres made of silica glass, acrylic resin, and aluminum alloy. The relative size and densities of the different pellet types are documented in Table 1,

Table 1. The Pellets Employed in These Experiments Were Made of Acrylic Resin, Glass, and Aluminum Alloy. The sizes and densities of the pellets are given in cm and grams/cm³, respectively

Pelle	Pellet Type		Pellet Type (cn.)		Density (gm/cm ³)	
Acrylic	red	1.97	1.02			
Resin	orange	1.24	1, 19			
	yellow	1.53	2.20			
Glass	brown	1.43	2.70			
	blue	1,55	1,92			
Aluminum Alloy		1.27	2.84			

The explosives used in these experiments were Hi-velocity gelatin, a mixture of 60 percent nitroglycerin and 40 percent inert material, and C-4, a mixture of 91 percent RDX (cyclonite) and 9 percent inert material. The relevant physical properties of these materials are compared with TNT and PFTN (pentaeryghritol tetranitrate) in Table 2. The explosive charges were spherically shaped and centrally initiated by bridge wire electrical detonators. Two types of detonators were employed, an 'SSS' EB Cap, Strength No. 8, sold by Dupont and an M6 EB Cap, Strength No. 12, which is the Standard Army EB Cap.

2.3 Experimental Procedure

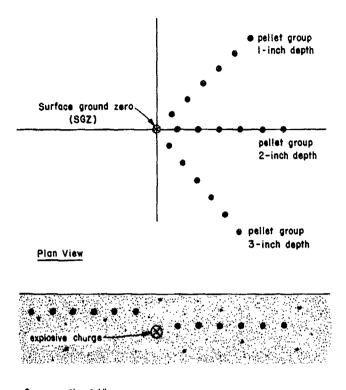
Pellets were emplaced within the test material 2 to 28 hours before the experiment (see Figure 3). Typically, several groups of pellets would be buried, with each group emplaced at a common depth along an imaginary horizontal line radial to a vertical centerline through the explosive charge. The radial range of an individual pellet was determined to within \pm 0.125 in. (measured from surface ground zero); its depth of burial was determined to within \pm 0.25 in. (measured from the original ground surface).

Table 2. The Physical Properties of the Hi-Velocity Gelatin and C4 Explosive Employed in This Study are Compared With Other Commonly Used Types of Explosives

C4 PETN 9 % RDX 9% inert	1120, 1385.	1.6	~8050. ~8300.	1.34	1.30
Hi-velocity gelatin 60% nitroglycerin 40% inert	1204.	1.3	~6000.	0.87	0.85**
TNT (Trinitrotoluene)	1080.	1.6	~6700	1.0	1.0
	Heat of Explosion (cal/g)	Density (g/cm ³)	Detonation Velocity (m/sec)	Relative Quickness*	TNT Equivalent Weight

*Relative 'quickness' is a military rating applied to different explosives on the basis of their explosive energy, density, and detonation velocity.

**TNT equivalent weight for Hi-velocity gelatin based upon relative 'quickness' and the results of the brisance sand test and ballistic pendulum test.



Cross-sectional View

Figure 3. Schematic Map of Pellet Emplacement. A variety of pellet groups emplaced at different depths are excavated by the explosion. (Note pellet size is greatly exaggerated)

In-situ soil moisture was monitored by a Soiltest speedy moisture tester which measures the gas pressure generated by a mixture of calcium carbide reagent and test site material. The moisture content of the upper 0.3 m of the test site ranged from extremes of 1.5 wt percent to 9.0 wt percent but more typically equaled 1.5 to 5.0 wt percent.

Experiments were conducted on good weather days when local wind conditions were suitably calm. Even so, higher level gusts with velocities on the order of 1.0 m/sec may have influenced the trajectories of some pellets.

After a test shot, the pellets were relocated and their range from the center of the crater determined to within \pm 0. 125 in.

3. PELLET BEHAVIOR

In order to describe the translation of the bulk of the crater ejecta by tracking artificial pellets, the pellets should ideally behave as point masses during the cratering event. This means that the pellet could be replaced by a quartz particle and the quartz particle would be translated to the postshot range observed for the pellet. Clearly this is not the case. The pellet sizes are necessarily larger than the average or median size of quartz grains in order to permit postshot identification. Air drag resistance to pellet motion depends upon its velocity, surface area, and the appropriate drag coefficient. While the surface area of the pellets is larger than that of the quartz grains, the drag coefficient characterizing the larger pellet sizes should generally be less than the drag coefficient to the quartz grains.

These counterbalancing effects make it difficult to contrast pellet translation ranges with the throwout distances of quartz grains of comparable density initially accelerated to similar ejection velocities. However, the ballistic studies of Sherwood indicate that pellet behavior should generally overestimate the translation of the smaller sized quartz sand.

The initial acceleration of material ejected by the explosive cratering event is produced by (1) the interaction of the individual particle with the compressional stress wave initially generated by the explosion and subsequent rarefaction waves reflected from the free surface of the ground, and (2) the interaction of the individual particle with the high velocity gases produced by the detonation of the explosive.

The effect of the size difference between the quartz grains and the artificial pellets on the relative particle accelerations imparted by the stress wave interaction mechanism is difficult to assess. In order to avoid differential accelerations of the in situ and emplaced materials, the strength of the pellet-quartz sand interface should approximate the strength of the quartz sand. It is not clear that this is the case. Recovered pellets occasionally have cone-shaped cappings of quartz sand that appear to have been compressed or molded onto the pellet surface. This may indicate that grain interaction initially accelerates some pellets to ejection velocities which exceed the velocities of quartz grains initially situated in similar preshot positions.

The velocity imparted to an individual particle by the accelerated gases vented from the expanding crater cavity will be proportional to the particle cross section. Therefore, the larger cross section of the pellets may cause them to be ejected at initial velocities greater than the velocity that would be imparted to a smrller quartz particle originally situated in a similar position. This would imply that the

^{25.} Sherwood, A. E. (1967) Effect of air drag on particles ejected during explosive cratering, Jour. Geophys. Res. 72:1783-1791.

postshot pellet range represents a maximum estimate of the postshot range of a quartz particle originally in a similar position.

It is difficult to quantitatively estimate the extent to which these different effects influence pellet motion. In addition, variations in pellet translation can result from (1) azimuthal variability in the detonation wave that travels through the explosive, (2) the natural heterogeneity of the quartz sand test medium, and (3) the variability of local air currents. The densities of the pellets bracket the range of density of the natural materials that make up the quartz sand fill. Therefore, by considering both size and density, the actual behavior of an individual pellet during the cratering event may best represent the behavior of the ccarsest fraction of the natural test material. In a later section, the translation histories of a group of pellets lying in a common radial direction will be compared with the translation of colored quartz sand tracer materials.

4. RESULTS

The pellet experimental program can be divided into three phases. The purpose of the first group of test shots was to determine the effects of charge size on the lateral translation of the artificial pellets. In this series of experiments, the explosive charge weight was varied from 1 to 4 lb at a constant scaled-depth-of-purst (SDOB). The second phase of experiments was designed to investigate the effect of variable scaled-depth-of-burst on the postshot pellet distribution. In this explosive series the charge weight was constant (5 lb) and the scaled-depth-of-burst varied from 0.20 approximately 0.55 ft/(lb TNT)^{1/3}. In the final phase, the generality of earlier results was tested by repeating the second phase of experiments using another type of explosive and different pellet materials. The results of the three phases will be discussed in this section. A compilation of the experimental field data is presented in Appendix A.

4.1 Crater Dimensions

The relationship between crater dimensions and the scaled-depth-of-burst of the explosive charge for all the craters produced by this experimental program is presented in Figure 4. For comparison, the crater depth (below rim crest)/radius (rim crest radius) ratios observed for a series of smaller scale experimental craters produced at the University of Dayton Research Institute (UDRI) are also shown in Figure 4C (see Pickutowski, 1974). 26

^{26.} Pickutowski, A.J. (1974) Laboratory Scale High Explosive Cratering and Ejecta Phenomenology Studies. University of Dayton Research Institute, AFWL-TR-72-155, Air Force Weapons Lab., Kirtland AFB, Albuquerque, New Mexico.

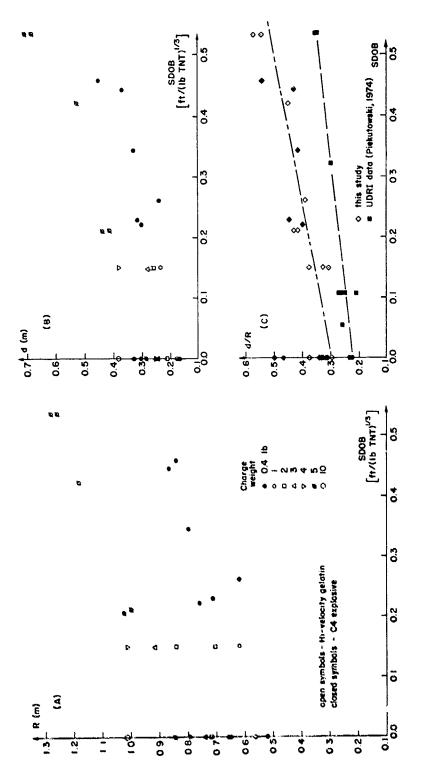


Figure 4. (A) Crater Rim Crest Radius R as a Function of Explosive Scaled Depth of Burst (SDOB). Open symbols represent Hi-velocity gelatin explosive; closed symbols represent C4 explosive. (B) Crater Depth d (measured from crater rim crest) as a function of explosive SCOB. (C) Ratio of crater depth (measured from crater rim crest radius as a function of explosive SDOB. In comparison, small explosion craters produced at UDRI are consistently shallower

The explosion craters produced by the present experimental series in quartz sand are consistently deeper and more bowl-shaped than the smaller scale UDRI craters. This probably reflects the greater natural cohesion of the quartz sand fill used in this study in contrast to the Ottawa sand employed in the UDRI experiments.

4.2 Presentation of Data

McGetchin et al²⁷ have suggested that the postshot range r of a mass point ejected by an explosive cratering event can be related to its preshot range x, measured from surface ground zero, by a simple power-law expression of the form

$$\frac{\mathbf{r}}{\mathbf{R}} \propto \left(\frac{\mathbf{x}}{\mathbf{R}}\right)^{\mathbf{c}},\tag{1}$$

where R is the crater radius and the exponent c is a negative number. The form of Eq. (1) is particularly useful for comparing the results of a series of pellet experiments since the radial distances r and x have been normalized to the radius of the apparent crater lip, R. These normalized ranges permit comparison of the results of this study with explosive cratering events conducted at different scales.

A graphical representation of the experimental data is schematically outlined in Figure 5A. A linear plot of the power-law expression [Eq. (1)] for a variety of values of c produces a family of curves that converge as x/R approaches 1.0, or, in other words, near the crater rim where x = R. Larger negative values of c correspond to greater distances of radial translation for groups of pellets emplaced at a common depth. It is more convenient for the purpose of this study to consider the pellet data in the logarithmic coordinate system shown in Figure 5B.

A logarithmic plot of Eq. (1) yields a family of straight lines which similarly converge near the crater rim where $\log_{10}(x/R=1.0)=0$. Representation of the experimental pellet data in this form will reveal; (1) how accurately Eq. (1) describes the postshot distribution of pellets (note that a straight line fit to the experimental data would verify that the power-law expression provides a 'perfect' description of the relationship between preshot and postshot pellet position); (2) the approximate value of c for groups of pellets emplaced at specific depths within the test medium (note that the slope of a line, and not its absolute position within the logarithmic plot, defines the exponent); and, (3) the approximate radius of the true crater of excavation (note that the R measured experimentally is the rim crest radius). Material has not been excavated out to the rim crest radius R

McGetchin, T.R., Settle, M., and Head, J.W. (1973b) A model for the distribution of impact crater ejecta and its implications, EOS Transactions Am. Geophys. Union 54, No. 4:357.

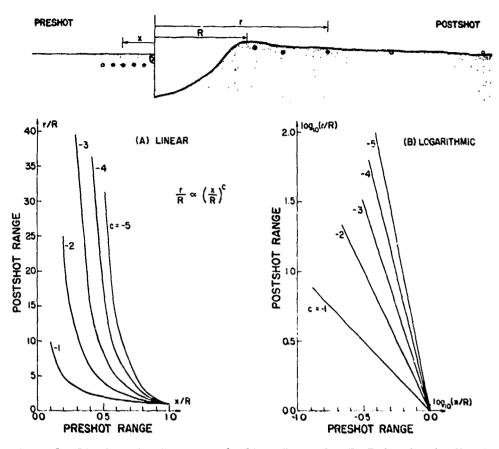


Figure 5. The Postshot Range r of a Mass Point Can Be Related to Its Preshot Range x (measured from surface ground zero) by a Power Law Expression. Figure 5A shows a linear plot of such an expression; 5B shows a logarithmic plot of the same expression. Data presented in this report will be plotted in the logarithmic format

since the material underlying the apparent rim crest consists of ejecta and structural uplift. The true limiting range at which material has been excavated can be approximately defined as the range x/R at which a straight line logarithmic fit to the pellet data equals 0.00. Graphically, this means that a straight line logarithmic fit to the actual pellet data will not pass through $\log_{10}(x/R=1.0) \approx 0.00$; however, the range x/R at which it crosses the line $\log_{10}(r/R=1.0) \approx 0.00$ will correspond approximately to the limiting range at which material was ejected by the cratering event (that is, the true radius of the crater of excavation).

Figure 5B also demonstrates the difficulty in determining an accurate value for the exponent c for a group of peliets that are transported to relatively small postshot ranges. This is the range of values of r/R in which the straight lines in Figure 5B converge. The recovery of pellets transported to large radial ranges

(that is, the region in which the straight lines diverge in Figure 5B) is extremely valuable in distinguishing between different values of c.

4.3 Effect of Charge Size on Postshot Pellet Distribution

Figures 6 and 7 show the results of two series of explosive cratering experiments in which the size of an explosive charge of Hi-velocity gelatin was varied from 1 to 4 lb at a constant scaled-depth-of-burst of 0.00 and 0.15 ft/(lb TNT) 1/3, respectively. Both acrylic and glass pellets were simultaneously employed in these two series of explosion cratering experiments. The pellet data in Figures 6 and 7 demonstrate that the acrylic resin and the silica glass pellets were transported to generally similar normalized ranges by the individual cratering events. No consistent discrepancy exists between the postshot distributions of the two types of pellet materials.

A straight-line fit to the experimental pellet data appears to be a reasonable approximation of the lateral translation of individual pellet groups emplaced at different preshot depths. The reference line c = -4 offers an approximate description of the distribution of postshot ranges for the group of pellets nearest the original ground surface for both SDOB = 0.00 and SDOB = 0.15 ft/(lb TNT)^{1/3}.

In Figure 6 (SDOB = 0.00) the deeper pellet group, originally situated at a depth of 2 in., is translated to significantly shorter ranges than the pellet group initially situated at a 1-in. depth. This consistent relationship, successively deeper levels of material being transported to successively shorter postshot ranges, results in the inverted stratigraphy observed in the rim ejecta deposit produced by larger scale cratering in layered materials. However, in Figure 7 (SDOB = 0.15) the difference between the postshot positions of pellets, originally at a 1-in. and 2-in. depth within the quartz sand test medium, is much less. This is because both the 1-in. and 2-in. depths within the test medium will behave as near-surface 'layers' during the deeper SDOB = 0.15 event. Even in Figure 7, the deeper pellets generally travel to shorter postshot ranges and lie below the postshot range curves of pellet groups originally situated nearer the ground surface.

A further comparison of Figure 7 with Figure 6 suggests that the slope of a straight line fit through the 1-in, pellet data of Figure 7 (not shown) would generally be steeper than a similar straight line fit in Figure 6 (see data in Appendix A). In relation to the configuration of the explosive charge, the 1-in, pellet group in the SDOB = 0.15 case lies at a 'shallower' level than the 1-in, pellet group in the SDOB = 0.00 case and shallower levels should be translated farther. Steeper curves are indicative of greater lateral dispersion of ejected material and hence a more energetic excavation process at specific depths and explosive SDOB.

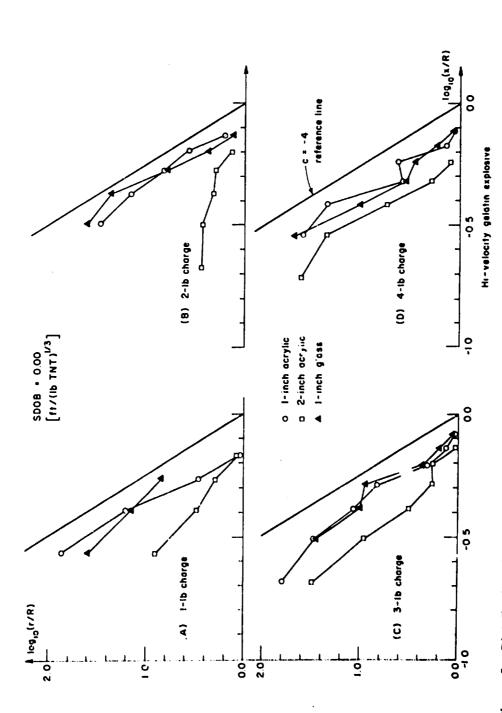


Figure 6. Distribution of Normalized Pellet Postshot Range for a Series of Experiments Employing Explosive Charges of Various Weights at a Constant SDOB = 0.00 ft/(lb TNT) ^{1/3}. (A) 1-lb charge; (B) 2-lb charge; (C) 3-lb charge; (D) 4-lb charge. Hi-velocity gelatin was used in this experimental series. The label "1-in, acrylic" refers to a group of acrylic resin pellets emplaced at a 1-in, depth within the quartz sand prior to the explosion (see Table 1 for other pellet types)

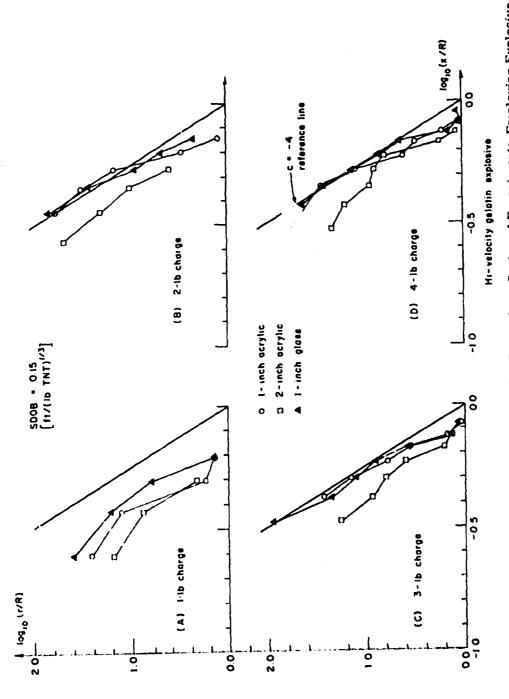


Figure 7. Distribution of Normalized Pellet Postshot Range for a Series of Experiment; Employing Explosive Charges of Various Weights at a Constant SDOB = 0.15 ft/(lb TNT) \$\frac{1}{3}\$. (A) 1-lb charge; (B) 2-lb charge; (C) 3-lb charge; (D) 4-lb charge. Hi-velocity gelatin was used in this experimental series. The label "1-in, acrylic" refers to a group of acrylic resin pellets emplaced at a 1-in, depth within the quartz sand prior to the explosion (see Table 1 for other pellet types)

This effect arises in the experimental data from a nonlinear increase in the coupling of explosive energy into the quartz sand test medium with increasing SDOB particularly in the near-surface range of SDOB from 0.00 to approximately 0.15 ft/(lb TNT) ^{1/3}. In addition, the lateral confining pressure of the quartz sand increases with depth. This stress inhibits the growth of the crater and limits initial ejection angles to generally higher values (measured from the ground surface) with increasing SDOB. Higher ejection angles will tend to limit the lateral dispersion of crater ejecta. The pronounced steepening of the Figure 7 (SDOB = 0.15) curves can thus be interpreted in terms of an increase in the efficiency of explosive coupling, which is not cancelled by the corresponding increase in lateral confining pressures. At greater SDOB, the increase in confining pressure (which inhibits crater growth) compensates the increase in coupling efficiency (which promotes the formation of larger craters).

Figures 6 and 7 summarize the distribution of postshot pellet ranges for explosion experiments conducted at a constant SDOB, over a 1- to 4-lb range of charge size. Inspection of the pellet data from a particular preshot burial depth in each case demonstrates no consistent change in lateral translation of the pellet group with variation of the size of the explosive charge. Figure 7A (SDOB = 0.15, 1-lb charge) appears slightly anomalous in comparison with the other three experiments performed at SDOB = 0.15 ft/(lb TNT). The cause of this discrepancy is unknown. However, the uniformity of the results of the three other experiments suggests that heterogeneity within the test site material and/or transient wind conditions may account for the pellet data presented in Figure 7A.

Finally, extrapolation of a straight line fit to the pellet data in both Figures 6 and 7 would intersect the abcissa $\log_{10} (r/R = 1.0) = 0$ at $\log_{10} (x/R) = -0.05$ to -0.15. This implies that the radius of the true crater of excavation is approximately equal to 70 to 90 percent of the measured rim crest radius.

4.4 Effect of Explosive Scaled Depth of Burst on Postshot Pellet Distribution

In order to observe the effect of the variable explosive SDOB on the translation of material ejected by an explosive cratering event, a series of experiments employing 5-lb Hi-velocity gelatin charges was conducted at SDOB ranging from 0.20 to 0.55 ft/(lb TNT) $^{1/3}$. The distribution of postshot pellet ranges for pellet groups emplaced at 2-in, and 3-in, depths in the quartz sand test medium are shown in Figure 8.

Surprisingly, the pellet data in Figures 8A (SDOB = 0.21) and 8B (SDOB = 0.42) reveal that the near-surface pellet groups (2 to 3 in.) within the quartz sand have been translated to normalized postshot ranges comparable to the normalized throwout distances observed for the corresponding near-surface pellet

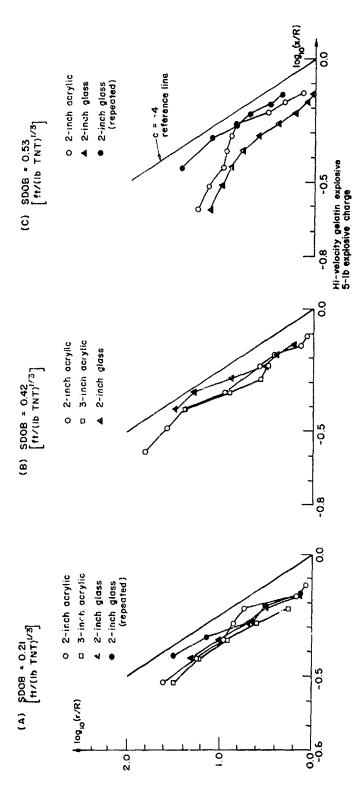


Figure 8. Distribution of Normalized Pellet Postshot Range for a Series of Experiments Employing Explosive Charges of Constant Size at a Variety of SDOB. (A) SDOB = 0.21 ft/(tb TNT)^{1/3}; (B) SDOB = 0.42 ft/(tb TNT)^{1/3}; (C) SDOB = 0.53 ft/(tb TNT)^{1/3}. Hi-velocity gelatin was used in this experimental series. The label "1-in, acrylic" refers to a group of acrylic resin pellets emplaced at a 1-in, depth within the quartz sand prior to the explosion (see Table 1 for other pellet types)

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groups excavated by the surface burst test series (see Figure 6, SDOB = 0.00). In both cases, a least-squares fit of a straight line through the experimental pellet data would be reasonably approximated by Eq.(1) with the exponent c representing the slope of the line approximately equal to -4 ± 1 (see Appendix A).

The pellct data in Figure 8C (SDOB = 0.53) is somewhat ambiguous. The translation of the two groups of silica glass pellets emplaced at a 2-in. depth differs. The trend of the data from the repeated experiment is similar to the dominant trends in Figures 8A (SDOB = 0.21), 8B (SDOB = 0.42), and 6 (SDOB = 0.00). However, the slope of a straight-line fit to the 2-in, pellet data from the initial experiment at a SDOB = 0.53 ft/(lb TNT)^{1/3} is shallower, suggesting a value of c = -2. The cause of this anomalous distribution of normalized pellet throwout ranges cannot be resolved. In the absence of any consistent trend in the data for the other buried cratering events [that is, Figures 8A (SDOB = 0.21) and 8B (SDOB = 0.42)], it is possible to attribute these relatively shallower sloping curves to heterogeneous physical properties within the test site material and/or transient wind conditions. Alternatively, this variation may be real in the sense that it indicates a decrease in the ability of the explosive cratering event to laterally transport ejected material at relatively larger SDOB. With increasing depth-ofburst of the explosive, the explosive energy released upon detonation becomes increasingly confined. Thus, since particle accelerations are initially directed radially away from the explosive, a transition may occur with increasing SDOB at which lateral particle motions are suitably confined to produce a decrease in postshot threwout ranges. For the particular charge size and quartz sand medium used in these experiments, the pellet data shown in Figure 8C (SDOB \cong 0.53) may be indicating a transition in the ability of an explosive cratering event to laterally translate material at a SDOB = 0.55 ft/(lb TNT) 1/3. This would suggest that within a certain range of SDOB bracketed by $0.00 < \text{SDOB} < 0.55 \text{ ft/(lb TNT)}^{1/3}$. the excavation process achieves a maximum ability to laterally translate ejected material beyond the crater rim. The discrepancy between the pellet data for the 2-in, level at a SDOB = 0.53 ft/(lb TNT) 1/3 (Figure 8C) may reflect the effect of variable physical properties of the test material on the actual value of such a transitional SDOB.

Comparison of Figure 8 with Figure 7 (SDOB = 0.15) demonstrates that the steepest pellet-data curves (implying the greatest lateral translation distances) observed in all test series are associated with the SDOB = 0.15 ft/(lb TNT) 1/3 explosive cratering events. This relationship is consistently observed in Figures 7B, 7C, and 7D. Therefore, the distributions of postshot pellet ranges shown in Figure 7 (SDOB = 0.15) cannot reflect natural variations in the quartz sand or transient wind conditions. This observation supports the concept of a

critical SDOB at which the lateral translation of ejected material is at a maximum. Furthermore, it suggests that this critical SDOB is in the range 0.10 to 0.20 ft/(lb TNT)^{1/3} for the quartz sand and 1- to 5-lb explosive charges employed in this study.

4.5 Effect of Experimental Materials on Postshot Pellet Distribution

A final series of explosive cratering experiments was conducted employing 1.0- and 1.1-lb charges of C4 explosive and spherical pellets made of aluminum alloy. A calibration test shot using acrylic resin, silica glass, and aluminum pellets and a Hi-velocity gelatin explosive was conducted at a SDOB = 0.26 ft/(lb TNT) $^{1/3}$ to compare the behavior of the three pellet types in a 'standard' explosive cratering event. The resulting postshot pellet distributions presented in Figure 9 show that the three pellet types are transported to generally similar normalized ranges.

The experimental test series employing the C4 explosive was conducted over a range of SDOB varying from 0.00 to 0.45 ft/(lb TNT) $^{1/3}$. The results presented in Figure 10 support the generality of Eq.(1) with $c = -4 \pm 1$ as an empirical description of the translation of near surface material ejected by an explosive cratering event at SDOB = 0.00 and at 0.23 < SDOB < 0.45. Unfortunately, no experiment was performed at a SDOB = 0.15 \pm 0.05 ft/(lb TNT) $^{1/3}$ in the range of the critical SDOB suggested by the results of the earlier experimental series.

Figure 10 also demonstrates that deeper levels within the quartz sand test medium are translated to significantly shorter ranges at all SDOB. In Figure 10D (SDOB = 0.45), the results of two explosive cratering experiments conducted at the same SDOB are presented together. These results show in part the variability of the behavior of the quartz sand test medium which is ejected and transported by the cratering event. (Compare, for example, the data for the 3-in. pellet depth from the two experiments.) Figure 10D also shows that the lateral translation of successive depths within the crater of excavation can be described by a series of equations having the form of Eq.(1) with the exponent c varying from ~ -4 to ~ -1 with increasing excavation depth. The possibility of comprehensively describing the translation of material transported by an explosive cratering event will be explored in the following section.

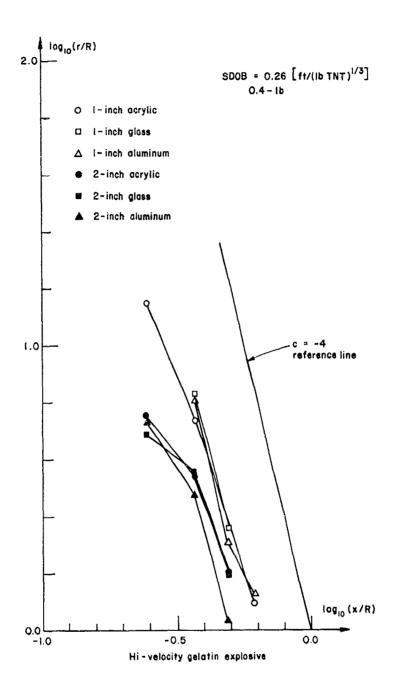


Figure 9. Distribution of Normalized Pellet Postshot Range for a Series of Experiments Employing a Variety of Pellet Materials and a 0.4-lb Charge of Hi-velocity Gelatin Explosive in a SDOB = 0.26 ft/(lb TNT)^{1/3} Configuration. The label "1-in. acrylic" refers to a group of acrylic resin pellets emplaced at a 1-in. depth within the quartz sand prior to the explosion (see Table 1 for other pellet types)

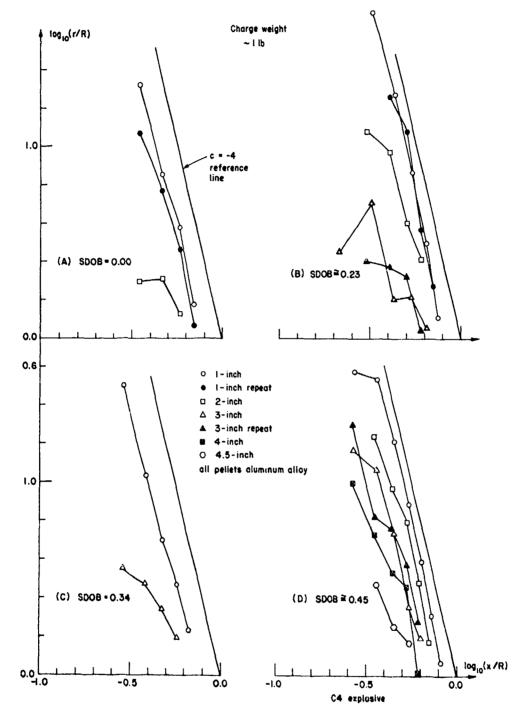


Figure 10. Distribution of Normalized Pellet Postshot Range for a Series of Experiments Employing Explosive Charges of Constant Size at a Variety of SDOB. (A) SDOB = 0.00 ft/(lb TNT) $^{1/3}$; (B) SDOB = 0.23 ft/(lb TNT) $^{1/3}$; (C) SDOB = 0.34 ft/(lb TNT) $^{1/3}$; (D) SDOB = 0.45 ft/(lb TNT) $^{1/3}$. C4 explosive was used in this experimental series. The label "1=in, acrylic" refers to a group of acrylic resin pellets emplaced at a 1-in, depth within the quartz sand prior to the explosion (see Table 1 for other pellet types)

5. DISCUSSION

The excavation process which accelerates material above the original ground surface is made up of two component mechanisms. 28,29 One mechanism is the complex interaction of the initial shock stress wave with the subsequent suite of rarefaction waves produced by reflection of the stress wave from the ground (free) surface. This family of rarefaction waves is essentially a broad relaxation pulse which provides for the continuous decompression of the shock-stressed material. The initial stress wave accelerates material radially away from the point of detonation while the rarefaction wave tends to re-orient the direction of individual particle velocity (see Gault et al⁸). Near the free (ground) surface the particle acceleration supplied by the stress and rarefaction waves act in a similar, outward direction. Material near the free surface is ejected at approximately twice the particle velocity to which material was initially accelerated by the stress wave. This phenomenon of stress wave interaction in the vicinity of the free surface has been termed 'spalling'. In hard rock materials, spalling creates new free surfaces below the original ground surface permitting continued stress wavefree surface interaction beneath the original ground surface. 30 In granular and soft rock materials, particle accelerations induced by the initial stress wave and the subsequent rarefaction waves do not act in the same direction below the immediate ground surface. The tensile rarefaction waves cause the radial flow field established by the initial stress wave to diverge. As a result, the acceleration of individual particles is re-oriented upward, contributing to the ejection of material beyond the transient rim of the growing crater and the plastic deformation of substrate material. This wave interaction phenomenon has been termed 'lateral flow' by Gault et al. 8 In both cases, spall and lateral flow, the kinetic energy of the ejected material is derived from the interaction of compressive and tensile stress waves propagating through the target or test material.

The second mechanism that excavates and ejects material from an explosion crater is gas acceleration. Nordyke²⁸ has described how the initial acceleration of ejected material can be significantly increased by the venting or expansion of gases produced by the detonation of the explosive materials.

Nordyke²⁸ has hypothesized that the wave interaction mechanism dominates the excavation process at shallow explosive depths-of-burst and is replaced by

^{28.} Nordyke, M.D. (1961) Nuclear craters and preliminary theory of the mechanics of explosive creter formation, Jour. Geophys. Res. 66:3439-3459.

^{29.} Short, N. M. (1965) A comparison of features characteristic of nuclear explosion craters and astroblemes, Annals N. Y. Acad. Sci. 123:573-616.

^{30.} Horz, F. (1969) Structural and mineralogical evaluation of an experimentally produced crater in granite, Contributions Mineralogy Petrology 21:365-377.

the gas acceleration mechanism at larger depths-of-burst (see Figure 11). At intermediate depths-of-burst, both mechanisms are important. In turn, experimental investigations have attempted to relate the morphology and distribution of explosion crater ejecta deposits to the two components of the excavation process. For example, the study of pellet data from the Air Vent/Flat Top Series of

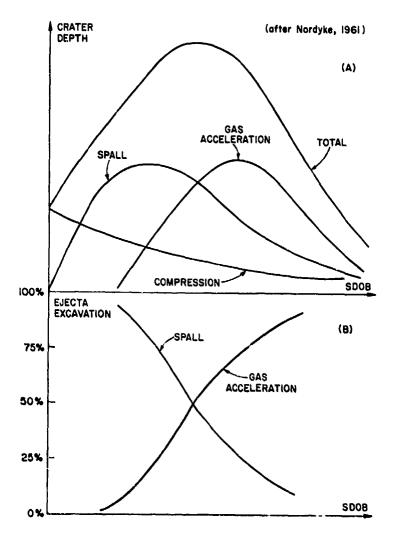


Figure 11. (A) Schematic Representation of the Relative Importance of the Mechanisms of Spall, Gas Acceleration, and Compression in the Formation of Explosion Craters with Increasing SDOB (after Nordyke, 1961), (B) Spall and Gas Acceleration are the Two Processes Responsible for Transporting Ejecta Beyond the Crater Rim. The relative importance of these two mechanisms at different SDOB is implied by Nordyke's (1961) model

explosion cratering experiments in playa and limestone mediums, led Ahlers ³¹ and Anthony ³² to characterize regions within the crater of excavation as sources of "ballistic ejecta" and "scoured ejecta" (Figure 12). These terms attempted to distinguish material that was accelerated and ejected into clearly definable ballistic trajectories (that is, "ballistic ejecta") from other material that appeared to be pushed or shoved up and over the crater lip (that is, "quared ejecta"). Ballistic ejecta originated from near ground zero and regions adjacent to the explosive charge and was transported to large postshot ranges. Scoured ejecta originated from regions beneath and beyond the ballistic zone and it was transported to relatively small radial ranges (see also Merritt, 1968). ³³

The maximum acceleration due to spalling can be anticipated at surface ground zero where the magnitude of the stress wave at the time of reflection will be greatest (that is, the travel time of the shock wave at the time of reflection will be a minimum directly above the detonation point). The fact that the area adjacent to surface ground zero is the source region of ballistic ejecta suggests an association between this material and the spall mechanism. The additional observation that the ballistic ejecta travels to distant ranges and is thus initially accelerated to higher ejection velocities than scoured ejecta, also supports such an association. Alternatively, the source region of scoured ejecta is situated at some distance from the detonation point. The acceleration mechanism responsible for the acceleration of the scoured ejecta can be inferred to be somewhat weaker than the dominant ballistic ejecta mechanism since this material is translated to significantly shorter ranges. In this case, an association is implied between the scoured ejecta and the gas acceleration mechanism. However, neither of these mechanisms is solely responsible for the translation of individual ejecta particles. Both spall and gas acceleration contribute to the kinetic energy of an ejecta particle, though the combination of the two component accelerations is undoubtedly more complicated than the simple vector addition of these two forces for individual particles.

The results of Ahlers³¹ and Anthony³² indicate that each of the two different mechanisms may dominate the excavation process for significantly different

Ahlers, F. B. (1965) Crater Ejecta Studies - Flat Tops II and III, Project 1, Sa, Ferris Wheel Series, Flat Top Event, POR - 3006, IIT Research Institute, Chicago, Illinois.

^{32.} Anthony, M. V. (1965) Ejecta Distribution from the Flat Top I Event, Project 1.5b, Ferris Wheel Series, Flat Top Event, POR - 3007, The Boeing Company, Seattle, Washington.

Merritt, M. L. (1968) Ferris Wheel Series, Air Vent/Flat Top Events, Project Officers Report, Scientific Directors Summary, POR - 3000, Sandia Corporation, Albuquerque, New Mexico.

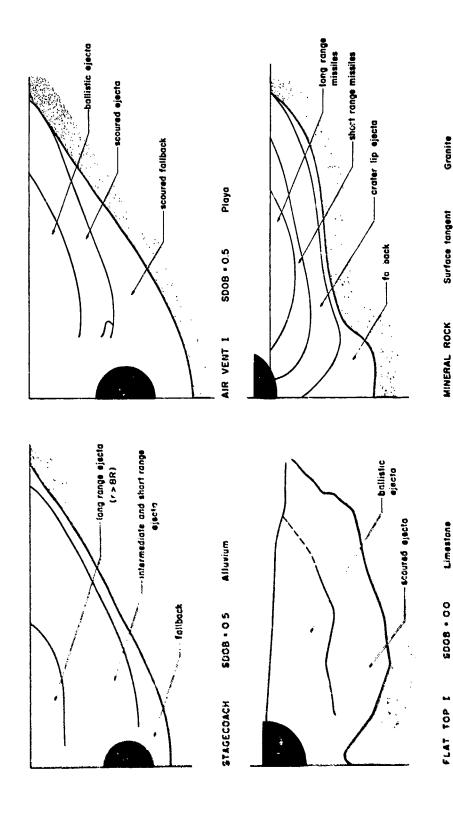


Figure 12. Ejecta Source Regions Within the Original Ground Surface for Large Scale Explosion Cratering Experiments (see text for references). Note that compression of substrate material, fallback, and post-excavation slumping may significantly regirizative the geometry of the ejecta source region to produce the apparent crater. (SDOB is given in R/(II TNT)^{1/3})

portions of the crater of excavation (see Figure 12). This is in addition to Nordyke's ²⁸ hypothesis that each of the two different excavation mechanisms should dominate the overall excavation process at different depths-of-burst (see Figure 11). Furthermore, the relative position of the ballistic and scoured zones within the crater of excavation mapped by the pallet data from the Flat Top Series suggests that ballistic ejecta is unloaded at an earlier stage of crater formation and is chronologically followed by excavation of scoured ejecta (Figure 12),

The later studies of Henny and Carlson were directed towards a quantitative description of the block distribution produced by explosive cratering in a hardrock basaltic medium. Their results characterize three modes of ejecta deposition:

Mode I consists of a blanket of missiles extending from the continuous ejecta distribution being roughly symmetrical to the crater. Mode II consists of missiles forming tongue-like structural lineaments extending radially out from the crater. Mode III consists of a number of missile clusters and/or individual missiles superimposed upon the first two modes and extending from the immediate vicinity of the crater outward to the maximum depositional range.

These three depositional modes were then related to initial ejection conditions which determine the ballistic trajectories of individual particles. Mode I is interpreted as an extension of the continuous deposit ejected from the crater of excavation at relatively small angles (for example, less than 25° measured from the original ground surface). Mode II is interpreted as material initially ejected at intermediate angles (for example, 25° to 65°). Finally, Mode III material is inferred to be high-angle ejecta which remains in flight for longer periods of time and is generally superimposed upon the first two morphologies. Though the separate modes are interpreted as beginning and ending in order, all three may occur simultaneously at intermediate ranges.

There is no straightforward relationship that defines the relative ejection velocity of particles which are ejected at different angles. Qualitatively, however, photographic investigation of the early stages of excavation suggests that ejection angle generally decreases as the radius of the transient crater increases. ¹⁷
Since material directly overlying the detonation point achieves the maximum ejection velocity, it is probable that the fastest material is ejected at the righer ejection angles (measured from the ground surface). Therefore, it is possible that the successively higher modes of ejecta deposit morphology are associated with both larger ejection angles and greater particle ejection velocities. ¹

The empirical description of the translation of pellet strings developed in the previous section [see Eq.(1)] is not related to specific excavation mechanisms. Rather, it expresses the observed relationship between pre-event and post-event pellet position without reference to the mechanics of excavation process. As

suggested previously, it may be possible to extend the simple power-law expression to a description of the translation behavior of pellets emplaced at a variety of levels within the crater of excavation. Ideally, parametrization of the power-law exponent c in terms of relative depth within the crater of excavation and the scaled depth of burst of the explosive charge would permit a continuous description of pellet translation for a variety of explosive cratering events. This is attempted in Figure 13 where the value of the exponent c (that is, the slope of the straight line determined by a least-squares fit of the pellet translation data presented in Appendix A) is plotted as a function of relative depth within the crater (that is, the ratio of the depth of burial of individual pellet groups/depth of the fresh crater measured from the original ground surface) for a variety of SDOB. It appears that the variation in c can be generally described by an S-shaped curve trending from large negative values of c for shallow levels within the crater of excavation to smaller, limiting negative values of c for deeper levels. This conforms to the earlier qualitative observation that successively deeper levels within the crater of excavation are laterally translated to relatively shorter ranges since larger negative c values characterize larger radial translations. In the deeper portions of the crater of excavation, compressive deformation and plastic flow of the underlying material plays a significant role in crater formation. The methods of surveying preshot - and postshot-peller positions employed in these experiments were not sufficiently accurate towarrant peilet emplace ment at depths greater than approximately half the anticipated crater depths where the phenomenon of plastic flow would considerably complicate pellet translation.

Figure 13 describes the average behavior of the artificial pellets and the granular quartz sand test medium over the range of ground moisture conditions and localized particle size distributions, and the performance of the explosive charges over their effective energy yields and their effective yield of caseous products which characterized the entire test program. However, the relative scalter over a range of depth and SDOB demonstrates that for a particular explosive cratering event (that is, SIX)H \approx constant), the translation of pellets at different levels within the granular quartz sand is most variable near the surface and becomes loss variable with increasing depth. In addition, the relative position of the approximate bounds which have been placed on the pellet data at different SIX)H (Figures 13A, B, and C) indicate that within increasing SDOB the radial translation of near-surface pellet strings (d < 0.7 d_{cr}) is significantly attenuated while the relative translation of intermediate levels within the crater of excavation (0.2 d_{cr} < d < 0.4 d_{cr}) remains approximately the same.

The possibility of a critical near-surface SDOB, at which pellet-translation distances achieve a maximum, is suggested by the large negative values of ϵ associated with shallow depths (d = 0.1 d $_{\rm CF}$) for SDOB = 0.15 N/(16 TNT) $^{1/3}$ in

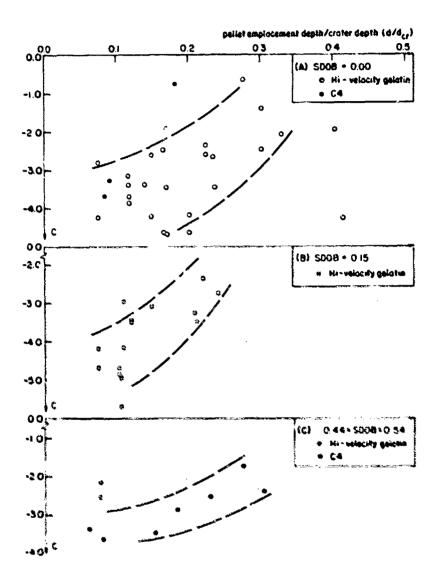


Figure 13. A Comparison of the Variation of the Exponent a liven Eq. 1) with Depth Within the Ejecta Source Region for a Variety of SIND. This exponent describes the relative translation of the artificial pellets. (A) SIND = 0.00 ft/(lb TNT) ^{1/2}; (II) SIND = 0.15 ft/(lb TNT) ^{1/2}; (C) 0.44 s SIND < 0.54 ft/(lb TNT) ^{1/2}. Note that the crater depth employed here is measured from the original ground surface

Figure 13B. Such a maximum has also been suggested by the preliminary results of the current U.S. Army program concerned with the effects of subsurface explosions, Project ESSEX.³⁴ In the context of the earlier discussion of excavation mechanisms, this value of SDOB may approximately mark the maximum in the lateral translation of ejected material produced by the combined effects of spall and gas acceleration shown schematically in Figure 11.

The results of this small-scale experimental program can be compared with two large-scale, 20-ton TNT explosive cratering events, in which detailed pellet experiments were also conducted. The results of these large-scale experiments, in which several hundred artificial pellets were used, are presented schematically as regions within the crater of excavation which are transported to some limiting postshot range. Such regions are delineated by equal postshot range contours within the crater of excavation similar to the generalized contours shown in Figure 12. The radial variation of the position of inferred isorange contours within the crater of excavation of the Stagecoach (SDOB = 0.50 ft/(lb TNT) 1/3, in alluvium) and Air Vent I (SIXOB = 0.50 ft/(lb TNT) 1/3, in playa) events have been fitted to the powerlaw expression used in this study at different depths within the crater of excavation (see Vortman and MacDougall (1962) and Merritt (1968), respectively). 33,35 (Note that translation data was not available for material initially situated at ranges less than 0.2 crater radii from surface ground zero, see Figure 12.) The trend of the Stagecoach and Air Vent I curves in Figure 14 generally corresponds to the SIXOB • 0.50 ft/(lb TNT) 1/3 data produced by the present study, but consistently lies at smaller negative e values. Such values indicate smaller normalized translation ranges for the emplaced pellets and are to be expected for larger scale events in which (1) test medium materials are better consolidated and (2) greater charge yields for events with similar SDOB require larger actual depths-of-hurst which result in larger lateral confining pressures in the region of charge detonation (see Sun. 1970; White, 1973), ^{36,37}

The pellet-translation experiments presented in this study have employed loose, relatively dry quarts sand under very low confining pressures as a test medium.

^{34.} Dishon, J. [1, 1375] ESSEN - Remond thre Research Fregram: Fixed Measurements Report - ESSEN I, Phase I, WES MP-E-75-3, U.S. Army Waterways Experiment Station, Explosive Expansion Research Lab., Livermore, California.

Vortman, L.J., and Martingell, H.H., etc. (1982) Project Stagecoarte 20
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 TID-4500, Sandia Corporation, Albequerque, New Mexico.

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Thus, the values of c describing pellet-postshot distribution reported here should represent maximum negative values when compared with larger scale explosion events in other geological environments.

The results of the present study can also be compared with smaller scale explosion cratering experiments conducted at the University of Dayton Research Institute (UDRI) using ~ 2-gm lead azide charges in Ottawa sand. 26 Dved sand was employed as a tracer material in a series of experiments in order to delineate translation ranges of material ejected from the crater of excavation. 38 Leastsquare fits to the power-law expression used in this study were performed using the data of Andrews³⁸ for SDOB = 0.00 and SDOB = 0.11 $fr/(1b \text{ TNT})^{1/3}$, and are presented in Figure 14. (Note that translation data for material initially situated at ranges less than 0.2-crater radii was not well resolved and was not used in calculating the power-law exponents shown in Figure 14.) Remarkably, there is a similarity between the variation of the mapping exponent c, with depth within the crater of excavation for the small scale UDRI experiments and the much larger scale 20-ton experiments. In comparison, the normalized translation ranges of the artificial pellets employed by the present study are much greater than the normalized ejecta-translation ranges reported by the smaller scale experiments and the normalized pellet-translation ranges reported by the large-scale experiments. This contrast is particularly supprising with regard to the smaller scale (UDRI) experiments in which smaller lateral confining pressures would a priori have suggested greater normalized ejecta-translation ranges (that is, larger negative values of the exponent of than the pellet-translation results of the present study.

The fact that the artificial pollets employed in this study are thrown to such anomalously large normalized ranges, indicates that they are not being translated in the same manner as the bulk of the ejecta. The critical difference between the experiments conducted here and the explosion events conducted at larger and smaller scales, is the relation of pollet size to ejecta-particle size. In the small-scale experiments, dyed sand was employed as the tracer material, and so the size of the 'pollet' tracer was approximately equal to that of the ejecta particle. In the larger scale experiments, artificial pollets ranged in size from 3/3 to 1-1/2 in. 33,33 while opera particles spanned a larger size range which included the sizes of the emplaced pollets. In this study, the artificial pollets were consistently larger than the charsest fraction of the quarte sand fill. Therefore, the similarity of ejecta-translation results of the small-scale UNRI experiments (pollet (dyed sand)

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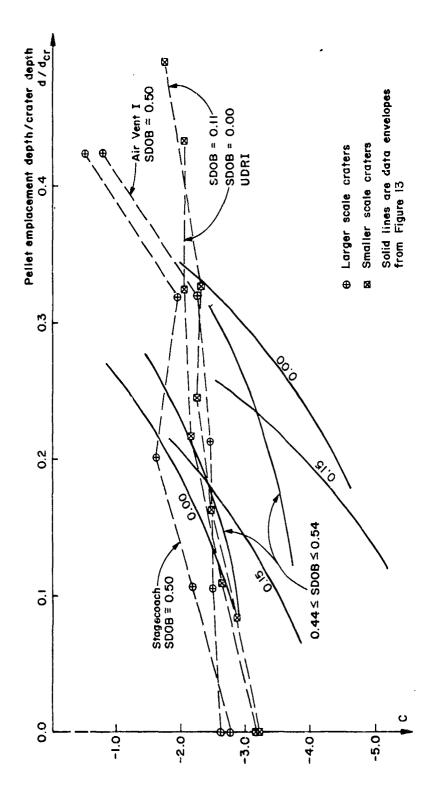


Figure 14. A Comparison of the Variation of the Exponent c [from Eq.(1)] with Depth Within the Ejecta Source Region for Explosion Experiments Conducted Over a Wide Range of Charge Size. Note that for the Stagecoach, Air Vent I, and UDRI experiments crater depth is measured from the original ground surface. Data trends from Figure 13 are also shown

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particle size \cong ejecta particle size] and the large-scale experiments (pellet-particle size \cong limited fraction of ejecta-particle size) suggests that these results represent reasonable descriptions of the translation of the bulk of the crater ejecta. Thus, for explosion craters with shallow depths-of-burst (0.00 \leq SDOB \leq 0.55) in relatively unconsolidated geological materials, the translation of material ejected from the upper one-third to one-half of the crater of excavation can be approximately described by Eq.(1) in which the exponent $c = -2.5 \pm 1.0$.

On the other hand, the present study indicates that the coarsest fraction of the material ejected by explosive events with shallow SDOB travels to significantly greater ranges than finer-sized material originally situated in a similar preshot position. Essentially, this is a restatement of the general sorting effects of atmospheric drag on ejecta deposition: finer material is preferentially decelerated and deposited near the crater rim while the ballistic trajectories of larger fragments are relatively less affected by the atmosphere. 25 However, a comparison of the pellet-translation data of the present study with the ejecta-translation results of the larger and smaller scale experiments, permits a more quantitative description of the actual size-related differences in the translation of explosion crater ejecta. In particular, for shallow explosive events in relatively unconsolidated geological materials, the pellet-translation results presented here suggest that the translation of the coarsest fraction of near-surface ejecta may be approximately described by a power-law expression of the form of Eq. (1), in which the exponent c = -4.0± 1.0. Furthermore, a maximum in the lateral translation of the coarsest size fraction of the ejected material may occur at a critical, near-surface SDOB. Such a maximum in the normalized translation range of the coarsest ejecta-size frections would not appear to correspond to the SDOB which produces a maximum crater volume.

6. CONCLUSIONS AND IMPLICATIONS

(1) The excavation of explosion crater ejecta is a complicated process which consistently transports successively deeper levels of the target or test medium to successively smaller ranges beyond the crater rim. Postshot analysis of the distribution of emplaced pellets in large-scale 20-ton TNT experiments and the distribution of dyed-quartz sand tracer materials excavated by small-scale gram-sized explosive events indicate that the bulk of the ejected material originates from the upper portions of the crater. This material is excavated as a continuous sequence of nested spherical segments or shells as the crater grows. Furthermore, the lateral translation of the bulk of the material ejected by shallow explosive events (0.00 < SDOB < 0.55 ft/(lb TNT) 1/3) within poorly consolidated geological materials

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(for example, sand and alluvium) is a surprisingly uniform phenomenon and can be empirically described by the expression:

$$\frac{\mathbf{r}}{R} \propto \left(\frac{\mathbf{x}}{R}\right)^{c}$$
 when $c = -2.5 \pm 1.0$ (bulk of the ejecta).

The lateral translation of ejecta originating from the upper portions of the crater of excavation remains approximately constant for 0.00 < SDOB < 0.55 ft/(lb TNT) 1/3 explosive events in poorly consolidated geological materials, whereas the crater depth/radius ratio increases by a factor of two with increasing SDOB.

Further experiments in a variety of softrock and hardrock materials would permit parametrization of the mapping exponent c for the bulk of the ejected material in terms of the physical properties of different earth media. Such a functional form for the mapping exponent could be used to quantitatively predict the postshot range of explosion crater ejecta as a function of its original position, the event SDOB, and the physical properties of the target or test medium.

(2) The coarsest fraction of explosion crater ejecta derived from unconsolidated geological materials will be translated to ranges which are much greater than the radial throwout distances which characterize finer-sized material initially situated in a similar preshot position. Values of c in the previous power-law expression, which describe the translation of this coarse-size fraction, lie in the range $c = -4.0 \pm 1.0$.

A comparison of the behavior of groups of artificial pellets emplaced within quartz sand demonstrates that (a) the translation of coarse material at near-surface levels is more highly variable than the translation of coarse material at intermediate levels for a particular type of event (that is, SDOB = constant), and (b) that with increasing SDOB, the translation of coarse material from near-surface levels is more strongly attenuated than the translation of coarse material originating at intermediate levels within the crater of excavation. These results imply that shallow bursts in poorly sorted unconsolidated geologic materials may eject significant amounts of blocky fragmental material well beyond the range of the continuous ejecta deposit. Further experiments in unconsolidated materials with different ranges of particle size would permit parametrization of the mapping exponent c for the coarsest ejecta-size fraction in terms of the degree of sorting of such materials.

(3) This study suggests that the lateral translation of coarser fractions of explosion-crater ejecta derived from unconsolidated geological materials may be maximized at a particular SDOB. Such a critical SDOB for the translation of the coarse-sized ejecta should not necessarily correspond to the SDOB producing maximum crater volume. The artificial pellets and quartz sand fill materials

suggest that this critical SDOB $\cong 0.15 \pm 0.05$ ft/(lb TNT) $^{1/3}$ for small explosive charges (1- to 10-lb TNT equivalent). Current understanding of the relationship between crater excavation and the process of ejecta deposition implies that the development of rays, and fragment chains and clusters within the zone of discontinuous deposition should be extensive for explosive events conducted at such a critical SDOB.

The threat that natural missiles pose to a nearby target surface is proportional to their size and velocity. Thus, a major conclusion of this study is that knowledge of the average translation of the bulk of the ejected material places a minimal constraint on the siting of "safe" surface structures. More realistic siting criteria should be based upon the translation of the coarser fractions of the explosion crater ejecta deposit.

- (4) Models of ejecta translation can be combined with models of energy distribution and stress wave propagation in order to predict the post-event location of material which has experienced various degrees of shock metamorphism. This material can then be sampled directly within the ejecta deposit and its post-event strength and physical properties can be studied in the laboratory in detail. In turn, improved understanding of how specific shock stress histories change the measurable physical properties of geological materials will make it possible to employ individual ejecta samples as in-situ barometers which reflect transient stress conditions within the crater at the time of formation. Ultimately, knowledge of the initial stress distribution produced by the explosive event and the postshot distribution of stress-induced physical property changes in the ejected material will supply the quantitative boundary conditions required for a comprehensive model of ejecta translation.
- (5) Caution is required in extrapolating the results of this study of explosion crater ejecta to the case of impact cratering. Oberbeck 17 and Baldwin 18 have demonstrated the similarity of crater dimensions, ejecta cloud growth, and subcrater deformation which can exist between craters formed by impact and craters formed by explosions within a limited range of SDOB. However, Oberbeck 17 has also demonstrated that projectile velocity critically influences impact crater dimensions and subsurface deformation. Projectile velocity may also critically influence the lateral translation of impact crater ejecta. The results of this study indicate that changes in the shape of explosion craters and the role of compressional deformation in crater formation do not severely change the observed translation of the bulk of the ejecta excavated by a variety of near-surface explosive cratering events. Since shallow SDOB events (SDOB = 0.25 ± 0.10 ft/(lb TNT)^{1/3}) provide an approximate analogy to the features of impact cratering mentioned above, this study tentatively supports the concept that the lateral translation of impact crater ejecta normalized to crater radius may be approximately uniform over a range of crater size and impact conditions even though impact and explosion cratering events are not identical phenomena.

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Appendix A

Field measurements of crater dimensions and pellet preshot and postshot ranges are presented in tabular form in this appendix. Table A1 serves as an index to the listing of the field data contained in Table A2. Table A1 can be used to identify the pellet groups employed in a specific experiment and provides data on pellet emplacement and the configuration of the explosive charge. Table A2 lists the preshot and postshot distances of individual pellets (measured from surface ground zero) and the results of a least-squares fit to the power-law expression discussed in this report [see Eq. (1)] for groups of pellets initially emplaced at a common depth beneath the original ground surface.

The explosion experiments are listed chronologically in both tables. In cases where incomplete or unreliable pellet data was returned from a specific experiment, it is not included in Table A2, although a description of pellet emplacement, charge configuration, and crater dimensions is provided in Table A1.

Guide to Table A1

DATE - date upon which the experiment was conducted.

EXPLOSIVE DOB (M) — explosive depth-of-burst (DOB), measured in meters from original ground surface to center of the explosive charge.

EXPLOSIVE TYPE - explosive material, see Table 2 in the text of this report.

EXPLOSIVE WT (LB) - explosive weight in pounds.

EQUIVALENT TNT WT (LB) — equivalent weight of a TNT charge in pounds, see Table 2 in the text of this report.

SCALED DOB — scaled depth-of-burst (SDOB) of the explosive charge determined by dividing actual charge depth-of-burst by the cube-root of the equivalent TNT charge weight (SDOB measured in ft/(lb TNT) 113).

Appendix A

PELLET DEPTH — depth of emplacement of a group of pellets measured from the original ground surface presented in centimeter and inch units.

PELLET TYPE - a description of the pellet material, see Table 1 in the text of this report (Al represents aluminum alloy pellets).

CRATER RAD (M) - crater rim crest radius measured in meters.

CRATER DEP (M) - crater depth measured from the rim crest in meters.

Guide to Table A2

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Experiments are referenced by an identifier phrase which gives DEVENS as the experimental site followed by the experiment date, charge weight, approximate description of scaled depth-of-burst, pellet type, and pellet emplacement depth. Crater rim crest radii are presented in meters. The variable x refers to preshot pellet range; r refers to postshot pellet range (both measured from surface ground zero). A least-squares fit to the power-law expression discussed in the text [Eq.(1)] is presented beneath a tabular listing of the field measurements. (The first number after the = sign is a multiplicative factor; the second number represents the exponent c in the power law expression.) The correlation coefficient represents a measure of goodness-of-fit; a value of 1.000 is indicative of an 'exact' fitting of the data.

Table A1. Index to the Listing of Field Data in Table A2

ATE E	EXPLOSIVE	EXPLOSIVE	FXPLOSTVF	FOUTVALENT	SCALFO	PFLLET	FFLLET	PELLET TYPE	CRATER	CRATE
UCT 73	0.600	HI-VEL	5.000	4.250	0.000	5.08	2.00	GREEN BLASS	.641	.261
OCT73	0. 111	मा-प्रम	5.707	4,257		7.67	7. 00	CALLA CLASS	. 84 [
OC 173	7.000	# T-VFL	5.700 5.898	4.759 6.257	0.000 7.000	7. FZ	2.00 3.75	ORANGE ACPYLIC	.841	. 28
INCT 73	0.000	HI-VEL	5.000	4.251	9.000	10.16	4. 00	ORANGE ACRYLIC	.841	. 26
40C TF 3	0.000	- HENDE	* 107867	E. 7:17	11.707	7.54	1.00	CREEN CEASS	1.015	.38
80CT73	0.000 8.000	mi-del Mi-del	1 P. 00P	6.509 5.570	0.000	5.0A 7.62	2.00 3.00	GPFFN GLASS	1.012	.38
90C T73	0.000	MI-AFF	17.010	P.537	7.707	2.56	1.00	OPANGE ACRYLIC	1.012	. 36 E.
80C773	0.070	HT-VFL	17.000	P.570	0.707	5.84	7.67	CHANGE ACRYLIC"	1.512	.38
80CT73	0.000	HT-VFL	10.300	4.500	0.000	7.42	3.00	CRANGE ACRYLIC	1.012	.36
100773	.044	HI-VEL	T.777	. 957	.151	7.54	2.00	DRANGE ACRALIC	.677	.23
100773		HI-ALF	7.307	. 777	.151	7.54	1.00	COLLA CT122	622	
100173	.155	H1-VEL	7.000	1.711	. 150	2.54	1.07	RED ACEYLIC	.841	.27
100777	. 875	MI-ALF	7.707	1.707	. 150	4.08	2.70	DANNE MEALTE	. 64.1	. 27
1 GC 77 3 1 GC 77 7	-055 - 0:099	H[-VFL	7.000 - 7.000	1. 793 2.997	.150	- 2.54	1.00	GREEN GLASS	.841	.27
100773	0.000	HI-VFL	*.99*	2.551	0.000	5.08	2.00	OPANGE ACATUIC	.738	.24
100777	0.070	47-7FL	1.700	2,550	0.900	2.56	1.07	CO EEN CLASS	.738	.24
100773	0.000	HI-VFL	4.787	3.403	0.000	2.54	1.00	GEL WEBAFFE	.792	.24
100773 100773	0.070	₩ [- ¥F L H [-¥FL	4.489 4.440	3.697 1.677	0.978	5.85 2.54	7.07 1.00	SPEEN GLASS	.792	. 24
60CT73	~~ * -465	41-46C	1.707		7.767	7.86	1 - M4	ALC SCHAFES	561	
6QC17J	0.000	4 7- V-L	1.707	.457	0.000	5.88	2.00	CHARGE ACRAFT.	.561	.17
800777	0.007	# T-VFL # I-VF1	1.000	. 457	7.877	7.54	1.77	SREEM REBSS " "	. 561	-17
606773	0.000 Tiper	MI-ALL MI-ALL	2.000 2.100	1.700	0.000	2.54 *.07	1.69 2.09	LESMEE MESALTE.	.719	21
60CT/3	0.000	41-4-1	101	1.717	7.767	7.67	7.67	GREEN GLASS	.719	.21
000177 -	. 862	#1-TPE	4.996	7.997	. 144	7.75	T.00	PEC SCRYLIC	916	.28
600773	.042	H [-VEL	3.200	2.553 2.559	.149	5.0 P	2.00	CHANGE SCHYLIC	.914	.28
600773 600773	.769	# [-4PL # [-4F1	7.989 4.790	3.511	.149	7.54	1.07	DED ACOAFIC	1.812	.78
BOCTFS	*****	MT-VPL	6.797	7.677	.157	5.99	2.77	ONANGE ACRYLIC	1.012	
60CTP3	.063	HI-VFL	4.000	3.471	. 150	7.54	1.03	GRFEN GLASS	1.012	.38
60CT79		min Ab f	2.997	1.777	.178	7.5%	1.07	BALL BURKETC	.705	
60C 173 8 0C1P1	.059	41-5FL 41-7FL	2.008 2.000	1.707	. 150	7.54	2.00 1.07	GREAR FURSE	.704	25
LPR74	114	HI-VIL	5.131	4.253	211	5.08	2. 67	SEC ACEALIC	1.024	.43
4PR74 -	.179	#1-44f	9.909	4,744	.711	7,67	3.01	WARRES REPARTS	1.025	
APRIL	.184	HI-ARC	5.310	6.751	.211	5.0	2.07	YFLLCH GLASS	1.024	.43
4PR74		₩##¥ ₽ ₹ ₩1-¥ F L	*.***	4.257	.422	*. ## 7.42	7.07	CHANGE ACRAFIC	1.183	.52
APR74 APRP4	.208 .209	41-47E	₹.900 ¶.990	4.287	.422	7.09	2.07	TFLLOW GLASS	1.183	.57
APRIL	.264	HI-WFE	5.999	4,251	.534	5.00	2.07	VELLOW GLASS	1.260	.68
JUNETY -	* ***	41-445	4.737	4.751	. 576	5.08	2.07	SEU BERAFIE	1.259	.71
JUNE74	264	₩ [-VFL 	5.000 4.909	4.250 4.257	434	5.09 7.80	2.50	PLUE GLASS	1.259	.71
JUNETY - - 9JULY74	0.007	H1-95L	5.207	4.257	0. 102	2.56	1.07	FFC ACPVLIC	.518	.17
SULT PA	*****	m f= yP f	9.990	4.759	9.969		1.07	PPCHM DESS	.518	
9JUL Y 74	0.000	HI-VEL	5.110	4.750	A.000	*.OA	2.09	PLUF GL 455	.518	.17
*****	8.000	mi-Aif	9.207	4.257	7.777	2.54	1.07	• t	-518	.17
9JUL 7 74	9.007 	Η [-V ^E [- Η [-V^E ξ	4.900 .900	4.26B	0.300 .202	5.88 +.90	7.00	FL CRANGE REPYLIC	-518	- 17
1306774	.044	HT-VFL	. 141	111	26.7	5.0A	2.01	REC ACPYLIC	. 622	.24
TULYPY	. 899	4 f-4-f	. 480	. ***	.767	7.54	1.77	PLUF GEASS "	.677	. 24
1 JULY 74	.055	47-VFL	. 100	.121	.262	5.04	2.00	BBCAN CFT24	•622	.24
13112 474		47-7° t	. 777	. ***	- 76.2	7.5	7.00	AL	627	.24
1JULY 74	.855	MI-VFE	. 181	. 171	24.2	5.00	2.01	/L	.622	.24
SEPT74	0.400	L # # \$-485	1.777	1.300	.757 0.000	7.82 2.54	1.00	AL	.654	.25
1266114	0.000	-	1.707	1.377	7.777	7.67	3.01	· it		.35
SEPT 74	8.077	P4	1.099	1.301	9.909	11.43	4.50	AL	.658	.32
366174	.074		1.707	1.777	.779	7.54	1.00	40	713	.34
ISEPT74 ISEPT74	.076 ; **79		1.909	1.177 ''' 7.777	• 229 • 77 9	7,62 11:55	7.87 4.50	- <u>1</u> (713	31
SEPT74	.152	Ch	1.007	1.377	454	2,54	1.00	Ã,	.841	.45
35-41-4-		CS	1.869	1.700	. 458	7.57	3.07	1[.841	,65
SEPT 74	. 152	64	1.009	1.300	.45A	11.43	4.50	A	.841	.45
1369174 ···		F18	1.000	1.300	. 144	2.54 7.42	1.00	AL	.799	.32
ISE PT 74 BSEPT P4	-114 	<u> </u>	1.000	1.311		12.78	5.07	-1 (-799	- :32
SEPT/4	0.000	C.	1.100	1.437	0.000	2.54	1.00	AL	. 652	. 30
3EPT74-	8.883		1.177	1.4 77	0.001	5.0F	5.44		.652	
35EPT /4	.976	C4	1 -1 07	1.437	.222	2.54	7.50	-1(759	30
7322774 - 5422774	.075	C4	1.107	1.477	.222	7.62	2.00 3.09	AL	.759	.30
93664.6#		· · · · · · · · · · · · · · · · · · ·	1.197			·	7.00		*882	. 16

Table A2. Preshot and Postshot Distances of Individual Pellets

		C Y 5.0	EEN GLASS, 2	The h	GRAIE	RADIUS (RC) =	METERS
	PR	ESHOT PELL	FT RANGES		SHOT PELLI	T RANGES	
PTELO DATAL	Ħ	N/PC	LOG18 (X/RC)		RIPC	LOGISTR/WCT	
	HETERS			METERS			
	.305	.3623	44891	23.997	28.5294	1.45923	
	.381	.4529	34400 26482	5.395 1.402	6.4138 T.8687	.0776	
	.533	.6341	19787	1.568	1.8877	.27185 .27593	
	.518	.7296	13988	1.376	1.6377	.21423	
		• • • •	•••••	••••			
LST 30 PIT T	c roc-roc	EQUATION	(4/4C) =	. 77 846 X/BC) **	-4.194	CORRELATION (OFFICIENTS (92)
PERTENS TOCAL PERTEL DENAM	OF MURTA	L = >.4		-	CHATES	RACIUSERCE .	INT METERS
		ESHOT PELL	FT RENGES	PCS		T PANGPS	
TELO DATAL	X HPTERS	N/RC	FUG 14 (XNEC)	R	R/ RC	FOCTB(B/BC)	
	.105	.3623	44891	2.405	2.9783	. 47396	
	. 36 1	.4529	14400	2.364	2.8152	.44951	
	.457	5435	26447	1.196	1.6594	.21996	
ST 90 FET T	0 106-106	FOUR TTOM	(P/RC) a	.775*(Y/PC) **		CAS A C: 477Ch /	*********
	0 506-506	CQ0#11(#	44,44	.//5-(1/#()-	-1.719	CORRELATION (OEFFICIENT
NEVENS 10CT?	315L8, HAL	F-AURIF7:C	FANGE ACRYLI	0.27854	CPATFE	. = (00) 2UI DA# 5	141 HETERS
ELLET DEPTH	OF BURLA	L = 4.8	P CH				
TPLO DATA4	Y Y	2/80 2/80	FT PANGES Login(X/PC)			T PANSFS	
TO DETAIL	METFRE	-7-6	FORTH (45%C)	#E1E#5	× 1 41	LOGIBIP/#C1	
	.305	. 3623	44991	11.777	16.3768	1.21923	
	. 761	.4529	34400	4.242	5.1014	.70769	
	.457	.44 ?4	" 4482	1.464	2.2210	. 34655	
	.533	.6791	19787	1.04*	1.2424	. 894 39	
ST 50 FIT T	0 L0G-L0G	FQUATION	(P/90):	. 148*(*/*C)**	-4.638		OEFFICIENT= .99
							•
			PANSE ACRYLIC	. T THCH	CRATER	RADIUS (PC) = .	141 METE #S
erret bebin			7PM FT PANGES			T ##MGE	
IELO DATA:	*	# 48C	LOG18 (X/8C)			L0G10(9/RC)	
	HE TER ;			METERS			
	. 165	. 9624	44591	7.164	1.7649	.47424	
	. 30 1	.4524	54400	1.244	1.5240	.14448	
	. 47 F	.7477	76 48 7	1.107	1.41 19	. 19016	
		EQUATION	(8/90)=	. 274*{1/00)**	-7.474	COPRELATION C	OEPPICIENT= .92
37 38 757 1	0 600-606						
							
EVENS 10CT7	315L9, HALI		FAMGE ACTVLIS	C+4-1454	CHATES	RADIUS(RC)= .6	41 HETEPS
EVENS 10CT7	315L9, MALI	L = 7.4;	?C*				41 HETEPS
EVENS 10077.	315t4, MALI OF RUPTAL	L =	704 T. PANGES		9117 PELLF	T RINGES	41 METERS
	315L9, MALI	L = 7.6; FSHCT PFLLI X/90	?C*		SHAT PELLE		41 METERS
EVENS 10077.	315L9, MALI OF RUPTAT	L = 7.6; FSHCT PFLLI */90 .3677	70* T PANGES===- Engle (#/PG) 64891		9117 PELLF	T RINGES	41 HETERS
EVENS 10CTP.	315L9, MALI OF RUPTAT T T METERS	L = 7.6; FSHCT PFLLI X/90	FU214 (ANDÚ) 1. bemuñ 2	#E1E86	9117 PELLF 8/40	T MANGES Logid (P/PC)	41 METERS
EVENS 10CTP ELLET DEPTH IELD DATAT	315L9, MALE OF RUPIAL THE PROPERTY METERS .305 .301	L = 7.5; FSHCT PFLLI */90 .367* .4579	704 T PANGES LOGIO (*/PC) 		9497 PELLE R/RC 2.1596 1.3913	T RANGES LOGGE (P/PC) .33434 .14347	
EVENS 10CTP ELLET DEPTH IELD DATAT	315L9, MALE OF RUPIAL THE PROPERTY METERS .305 .301	L = 7.5; FSHCT PFLLI */90 .367* .4579	704 T PANGES LOGIO (*/PC) 		9497 PELLE R/RC 2.1596 1.3913	T RANGES LOGGE (P/PC) .33434 .14347	
EVENS 10CTP. ETLET DEPTH TELD ORTAT	31519, MALI OF RUPTA PRI X METERS -305 -301 7 LOS-LOG	L = 7.4; FTHOT PELL! *** **36** **45*9 **5*9 ************************	704 T PANGES ENGIG TEXPOS 		9407 PELEF R/RC 2.1596 1.3917	T RANGES LOGGE (P/PC) .33434 .14347	COEPFICIENT = 1.000
EVENS 10CTP FELET DEPTH TELB DATA* ST SQ FIT 76	315L 9, MALE OF BUPTAT X METERS .385 .381 7 LOS-LOG	L = 7.5; FROT PELLI X/90 .3677 .4579 EQUATION ALF-BUSIEN L = 7.57	TO PANCES LOGICANOCS		9/07 PELLE R/RC 2.1596 1.3913 1.970 CRATER	T BANGES LNGE IP/PC1 .31434 .14342 .COPRFLATION C	COEPFICIENT= 1.80(
EVENS 10CTP. FELET DEPTH TELD DATAT ST SO FIT TO EVENS 100CT	315L9, MALI OF BUPTA ************************************	L = 7.5; FROT PELLI X/90 .3677 .4579 EQUATION ALF-BUSIEN L = 7.57	704 T PANGES ENGIG TEXPOS 		9401 PELLF P/RC 2.1594 1.3913 -1.970 CRATER	T MANGES LOGIO (P/PC) .33536 .15367 .COPRFLATION C	COEPFICIENT= 1.80(
EVENS 10CT? FELET DEPTH SELO DATAY ST SO FIT TO EVENS 10CCT	315L9, MALI OF RUPTA *** *** *** *** *** *** ** ** ** ** *	L = 7.6; FSMCT PFLUI X/40: .367* .4579 EOUPTION ALF-BUSIED: L = 2.9; ESMCT FELLI X/40:	17 PANCES LOGIO (XVPC) 64091 74400 (PVPC) = ICREFN GLASS NOT		SHOT PELLE R/RC 2.1594 1.3913 -1.970 CRATER SHOT PELLE R/RC	Y MAMCES LOGIOIP/PC) .33%3% .193% .COPRELATION C PADIUS(PC)=1.0	COEPFICIENT= 1.80(
EVENS 10CTP. FELET DEPTH TELD DATAT ST SO FIT TO EVENS 100CT	315L9, MALI OF RUPTAI ** ** ** ** ** ** ** ** ** ** ** ** **	L = 7.5; FRHOT PFILIT X/PC .367* .5579 EQUATION BLF-BURIED: T Z.91 ESHCT FELLIT X/PC .376F	704 1 PANCES LOGIGIZ/PCI		9401 PELLF P/RC 2.1594 1.3913 -1.970 CRATER	Y MAMCES LOGIOIP/PC) .33%3% .193% .COPRELATION C PADIUS(PC)=1.0	COEPFICIENT= 1.80(
EVENS 10CTP. FELET DEPTH TELD DATAT ST SO FIT TO EVENS 100CT	315L9, MALE OF BUFTAL 37 MFFFRS -305 -301 7 LOS-LOG F3110L8,MI OF BURTAL PRE MFTERS -301 -457	L = 7.6; FSMCT #FLMCL	704 T PANCES LOSIGITYPOS, 64891, 7480 (6780) = 10000 =		1941T PELLF B/RC 2.1594 1.3913 -1.970 CPATER SHOT PFLLE R/RC 19.8215 21.8530	Y MAMES LOGIO (P/PC) .31%74 .1%3%7 .COPRELATION C PADJUS (PC)=1.0 T MAMES LOGIO (P/PC)	COEPFICIENT= 1.80(
EVENS 10CTP. FELET DEPTH TELD DATAT ST SO FIT TO EVENS 100CT	3151.9, MALIO OF RUPTAIN OF RUPTAIN 305 305 301 305 301 405-LOC F3:101.0, MITCH 705-LOC F3:101.0, MITCH 301 457 533	L = 7.6; FSMCT FELL X/9C .3677 .4579 EQUATION BLF-BURIED L = 7.9; ESMCT FELL X/9C .3767 .4521 .4274	70% T PANCES LOGIG (X/PC), 64891, 74480 (6/PC) = 1000000000000000000000000000000000000		2-1594 1-3913 1-3913 1-1-970 CRATER SHOT PFELE R/RC 19-0215 21-0530 13-6517	T MAMER LOGISIP/PC) .33%4 .163%7 .COPRFLATION C PADIUSIPC)-1.0 T MAMERS LOGISIP/PC) 1.59173 1.15627 1.13454	COEFFICIENT= 1.80
EVENS 10CTP. FELET DEPTH TELD DATAT ST SO FIT TO EVENS 100CT	3151.9, MALIO OF RUPTAL OF	L = 7.6; FSMCT #FLMC #747 .3677 .5529 EOHATICH ALF-BUSIEN: L # 2.91 TSMCT #ELL! X/#F .3767 .6521 .6028	70% 1 PANGES LOGIGIX/PGI		2-1594 1-3917 -1-970 CPATER SHOT PELLE R/RC 79-0275 21-0530 13-6517 9-0224	Y MANGES LNG101P/PC) .33434 .19342 .COPRFLATION C PA03U3(PC)=1.0 T MANGES LOG101P/PC) 1.99173 1.36273 1.3527 1.33527	COEFFICIENT= 1.80
EVENS 10CT? FELET DEPTH SELO DATAY ST SO FIT TO EVENS 10CCT	31519, MALIO OF RUPTAL STATE O	L = 7.6; FSMCT FELL ***********************************	70% T PANCES LOGIG (X/PC),64991,7440 (P/PC) = 10REFN GLJ45, NOT 11 PANCES LOGIG (X/PC),2797,1647,27776,1986		2-1594 1-3913 1-3913 1-1-970 CPATER SMOT PFLLE R/RC 19-0215 23-0530 13-6317 9-0324 6-8071	Y MAMCES LOGIOIP/PC) .33%3% .1%3% .COPRELATION O PADJUSIPC>-1.0 Y MAMCES LOGIOIP/PC) 1.99133 1.36273 1.31507 .65188	COEFFICIENT= 1.80
EVENS 10CTP. EELET DEFTM IELE DATA: ST SO FIT TO EVENS 10CCT: EELET DEFTM IELE DATA:	3151.9, MALIO OF RUPTAL AND	L = 7.6; FSMCT FELU */90 .367* .6579 EOMATICN BLF-BURIED T 7.91 TSMCT FELL X/80 .5767 .6521 .5276 .628 .6781 .7535	TO MINICES LOGIGITA/PCI, 6-891, 7-4-80 (6/9C) = IGREFN GLASS, TO MANGES LOGIGITAN/PCI, 7-4-6-70, 7-19-6-7, 16-80-9, 12-79-6		2-1594 1-3913 1-3913 1-1-970 CPATER SMOT PFLLE R/RC 19.0275 21.0530 13.6317 9.0224 9.0215 13.6317	Y MANGES LNG101P/PC) .33434 .19342 .COPRFLATION C PA03U3(PC)=1.0 T MANGES LOG101P/PC) 1.99173 1.36273 1.3527 1.33527	COEFFICIENT= 1.80
EVENS 10CTP. EELET DEFTM IELE DATA: ST SO FIT TO EVENS 10CCT: EELET DEFTM IELE DATA:	3151.9, MALIO OF RUPTAL AND	L = 7.6; FYMOT PELLI */PO .367* .6579 EDMATICN BLF-BURIED T 7.91 STACT FELLI */PF .5767 .6521 .7735	70% 1 PANCES LOGIGITAPOS, 6-891, 7-6-80 (6-70) = 100 PCS		2-1594 1-3913 1-3913 1-1-970 CPATER SMOT PFLLE R/RC 19.0275 21.0530 13.6317 9.0224 9.0215 13.6317	Y MAMCES LOGIGIP/PC) .33%34 .193%2 .COPRELATION O PAGIUS(PC)=1.0 T MAMCES LOGIGIP/PC) 1.991%3 1.16273 1.13%5 .5%16 .60188 .27576	OEFFICIENT= 1.80(
EVENS 10CTP ELLET DEPTM IPLO DATA* ST SQ FIT TO EVENS 180CTI PELLET DEPTM IPLO DATA*	3151.9, MALIO OF RUPETAL STATE OF RUPETA	L = 7.6; FYMOT PELLI ***/90 .367* .6579 EDIPATION ***********************************	70% 1 PANCES LOGIGITAPOS, 64891, 7480 (6780) = 100001 = 1000001 = 1000001 = 1000001 = 1000001 = 10000001 = 10000000000		2.1594 1.3917 -1.970 CDATER SMOT DFLLE R/RC 79.0275 21.0530 13.6317 9.0224 4.8071 1.6617	Y MAMER LNG101P/PC) .31%7 .193%7 .COPRFLATION C PADJUS(PC)=1.0 T MAMERS LOG101P/PC) 1.991%3 1.13%7 1.13%7 .5%1% .6018 .2757% .CORRFLATION C	OEFFICIENT» 1.80
EVENS 10CTP. EVENS 10CTP. ST SQ FIT TO EVENS 180CT. EVENS 180CT. EVENS 180CT. ST SQ FIT TO	3151.9, MALIO OF NUMERICAL STATE OF SUPERICAL STATE	L = 7.6; FSMCT FELL */90 .3674 .4579 EOMATICN &LF-BUSIEN: .7 2.5! SMCT FELL **X/8P* .45721 .45721 .45721 .4773 .6026 .6781 .7535 FQUATION &LF-BUSIEN ** ** ** ** ** ** ** ** ** ** ** ** **	TO MATES LOSIGITATION		2.1594 1.3917 -1.970 CDATER SMOT DFLLE R/RC 79.0275 21.0530 13.6317 9.0224 4.8071 1.6617	Y MAMCES LOGIGIP/PC) .33%34 .193%2 .COPRELATION O PAGIUS(PC)=1.0 T MAMCES LOGIGIP/PC) 1.991%3 1.16273 1.13%5 .5%16 .60188 .27576	OEFFICIENT» 1.880
EVENS 10CTP ETER DEPTH ITELD DATAT SY SQ FIT TO EVENS 10CCT ETER DEPTH ITELD DATAT	3151.9, MALIO OF NUMERO NATIONAL NATION	L = 7.6; FSMCT FELLI ***/90 .367* .6579 .6579 EOUATION ***ENUT FELLI ***/**/ ***/**/ ***/**/ ***/**/ ***/**/	TO MARKES LOGIDITATION, 6-091, 7-400 (6-76) = IGREFN GLASS, TO, 10010 X 700, 1		2.1594 1.3917 -1.970 CDATER SMOT DFILE R/RC 19.0275 21.0530 13.6317 1.6817 -4.231	Y MAMER LNG101P/PC) .31%7 .193%7 .COPRFLATION C PADJUS(PC)=1.0 T MAMERS LOG101P/PC) 1.991%3 1.13%7 1.13%7 .5%1% .6018 .2757% .CORRFLATION C	OEFFICIENT= 1.880
EVENS 10CTP. ELLET DEPTH IPLO DATAT ST SQ FIT TO EVENS 180CT: ELLET DEPTH IPLO DATAT ST SQ FIT TO EVENS 10CT TO	3151.9, Mali OF RUPTAI 	L = 7.6; FSMCT FELLI ***/90 .367* .6579 .6579 EOUATION ***ENUT FELLI ***/**/ ***/**/ ***/**/ ***/**/ ***/**/	TO MATES LOSIGITATION		2.1594 1.3913 -1.970 CDATER SHOT PFLLE R/RC 79.0275 23.0530 13.6317 9.0224 5.8571 1.6817 -4.231 CRATER	T MAMES LNG1010/PC) .31%74 .1%3%7 .COPRFLATION C PAOJUS:PC>=1.0 T MAMES LOG1010/PC) 1.991%3 1.1562%3 1.13%9% .65%36 .60108 .275%6 COMMELATION C	OEFFICIENT» 1.80
EVENS 10CTP. ELLET DEPTH IPLO DATAT ST SQ FIT TO EVENS 180CT: ELLET DEPTH IPLO DATAT ST SQ FIT TO EVENS 10CT TO	3151.9, MALIO OF RUPETATO STATE OF RUPETATO STAT	L = 7.6; FYNOT FELLI */FYNOT FELLI */FYNOT FELLI *** *******************************	TO MARKES LOGID (#2/PC), %4991, %4991, %4991 (P/PC) = IGREFN GLASS, FT BANGES LOGID (#/PC), %4570		2-1-94 1-3913 -1-970 CPATER SMOT PFLLE R/RC 19-0275 21-0530 13-5317 9-0224 -8071 1-6817 -4-231 CRATER	T MAMES LNG101P/PC) .33%7 .193%7 .COPRELATION C T MANGES LOG10P/PC) 1.591%3 1.15273 1.13%5 .5%16 .60188 .27576 CORRELATION C T MANGES LNG10FP/PC)	OEFFICIENT= 1.80(
EVENS 10CTP ELLET DEPTM IPLD DATA* ST SQ FIT TO EVENS 180CTI EVENS 18	3151.9, Mali OF NUMERAL 	L = 7.6; FSMCT FFLU X/9C .3677 .4579 EOUATICN BLF-BURIED L Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z	TOWNESS LOGIG (X/PC), %4891, %480 (6/PC) = IGREFN GLASS, AND LOGIG (X/PC), %2797, 344791294 (W/RC) = IGREFN GLASS, CHITTON, 1086912294 (W/RC) = IGREFN GLASS, CHITTON, 10869, 12294 (W/RC) = IGREFN GLASS, CHITTON, 10869, 12294, 10869, 12294, 10869, 12294, 10869, 12294, 10869, 12294, 10869, 10869		2-1594 1-3913 -1-970 CRATER SMOT PFELE R/RC 19.829 1-6531 9.8294 1-6817 1-6817 -4-231 CRATER	T MAMCES LOGIO IP/PC) .33%34 .193%2 .COPRELATION C T MANGES LOGIO IP/PC) 1.591%3 1.35%27 1.35%7 .60108 .27576 CORRELATION C RAGIUS (#C)=1.0 T MAMCES LOGIC (IP/PC) 1.01290	OEFFICIENT= 1.880
EVENS 10CTP. ELLET DEPTH IPLO DATAT ST SQ FIT TO EVENS 180CT: ELLET DEPTH IPLO DATAT ST SQ FIT TO EVENS 10CT TO	3151.9, MALIO OF NUMERICA NAME OF NUMERICA NAME OF SUPERICA NAME OF SUPERI	L = 7.6; FSMCT FELL ***/90 .367* .6579 EDIFFICE *** **** ***** **** **** **** **** *	TO MARKES LOGIDITE/PO), 64891, 7480 (6/90] = IGREFN GLASS, IT MANGES LOGIDITE/POS, 74870, 74870, 16869, 12294 (8/90) = IGREFN GLASS, IGREFN GL		2.1594 1.3917 -1.970 CPATER SMOT PFLLE R/RC 79.8275 21.8530 13.6317 9.8274 1.6817 -4.231 CRATER CRATER 18.3014 5.4899	T MAMES LNG101P/PC) .31%7 .1%3%7 .COPRFLATION C T MAMES LOG10FP/PC) 1.59173 1.13%5 .5%16 .27576 CORRFLATION C RAGIUS(RC)=1.0 T MAMES LNG1(FP/PC) 1.012791 1.13791 1.13791 1.13791 1.13791	OEFFICIENT= 1.880
EVENS 10CTP. ELLET DEPTH IPLO DATAT ST SQ FIT TO EVENS 180CT: ELLET DEPTH IPLO DATAT ST SQ FIT TO EVENS 10CT TO	3151.9, Mali OF NUMERAL 	L = 7.6; FSMCT FFLU X/9C .3677 .4579 EOUATICN BLF-BURIED L Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z	TOWNESS LOGIG (X/PC), %4891, %480 (6/PC) = IGREFN GLASS, AND LOGIG (X/PC), %2797, 344791294 (W/RC) = IGREFN GLASS, CHITTON, 1086912294 (W/RC) = IGREFN GLASS, CHITTON, 10869, 12294 (W/RC) = IGREFN GLASS, CHITTON, 10869, 12294, 10869, 12294, 10869, 12294, 10869, 12294, 10869, 12294, 10869, 10869		2-1594 1-3913 -1-970 CRATER SMOT PFELE R/RC 19.829 1-6531 9.8294 1-6817 1-6817 -4-231 CRATER	T MAMCES LOGIO IP/PC) .33%34 .193%2 .COPRELATION C T MANGES LOGIO IP/PC) 1.591%3 1.35%27 1.35%7 .60108 .27576 CORRELATION C RAGIUS (#C)=1.0 T MAMCES LOGIC (IP/PC) 1.01290	OEFFICIENT= 1.880

Table A2. Preshot and Postshot Distances of Individual Pellets (Cont)

```
CRATER RADIUS (VC) #1.011 METERS
                                                                                                                                                             LOGINIR/VC)
FIELD DATAS
                                                                                                                   Q
METERS
19.266
14.402
7.438
                                                                                                                                        19.0506
14.2405
7.4511
1.0651
2.3207
                                                       .2760
.3014
.9767
.4521
.5275
                                   FTFRS
.229
.305
.581
.457
.433
                                                                                 -.64502
                                                                                -.6458?
-.52888
-.47597
-.34479
-.27/84
-.71945
                                                                                                                      3.100
                                                                                                                                           1.9289
                                                                                                                                                                PORRELATION COFFETCIENTS . 9779
EST 50 FIT TO LOG-LOG ENDAFTON (PZPC) = .654* (CZPC)** -7,657
 CRATER OAD DISCIPCE #1.011 METERS
                                                                                                                   #57585
16.715
16.703
17.567
10.025
4.736
3.951
                                                                                                                                         18.5051
16.5150
12.4262
9.3126
0.6721
3.8577
1.6576
1.1357
                                                                                  ~.5798P
~.62397
~.36670
~.27786
~.21985
~.16789
~.12796
~.48156
                                                          . TO 16
. 3767
. 4521
. 5274
. 6078
. 6781
. 7535
. 8288
                                                                                                                                                                    1.21790
1.09434
.94619
  LST SQ FIF TO LOG-LOG ENLATION (R/PC) . 1.039*(4/90)** -7.8%
                                                                                                                                                                  CORRELATION COEFFICIENTS . 9371
  CRATER PARTUSINGS =1.011 METERS
                                                                                                                                       17.4864
8.4996
7.4151
4.2154
4.9138
                                                                                                                                                                    1,24279
,62426
,85884
,62525
,59139
                                                                                                                     we te se
17.664
4.446
7.489
4.767
,.967
7.716
                                                           .3614
.1767
.4921
.5274
.6724
.6781
.7935
                                                                                   -,5284#
                                     + TERS

+ 105

+ 361

+ 497

+ 533

+ 616

+ 666

+ 762
                                                                                - 17288
- 187147
- 18679
- 17778
- 16869
- 17296
                                                                                                                                            2.1911
1.2548
                                                                                                                                                                        .10031
   EST-SQ FIT TO EDG-LOG TOURISM (P/RC)= .762*(*/RC)** -2.618
                                                                                                                                                                    PRESELECTION COEFFICIENTS .9768
  CRATTE PANTUS (RC) +1.811 METERS
                                                                                                                      # F F F # 5
                                                                                  -.64582
-.52088
-.62797
-.27784
-.71985
                                                                                                                      11.425
5.452
2.047
2.155
1.414
                                                                                                                                            11.6978
                                      ,229
,105
                                                                                                                                              1.9399
4.7752
2.9596
2.1309
1.0066
                                                             . 1014
                                                                                                                                                                         . 47124
                                                                                                                                                                         03287
                                                                                                                                                                 CORRELATION COEFFICIENT: .9796
   LST SQ FIT TO LOG-LOG EQUATION (8/90) = .361*(1/90) ** -2.156
   CRATER PARTIES INCOME . 477 METERS
                                                                                -,61179
-,63699
-,81906
-,21115
                                                             .2449
.3429
.4867
.4121
                                                                                                                                             74.56RS
                                                                                                                       15.971
4.105
1.117
.935
                                       . 157
. 729
                                                                                                                                            11.0264
                                                                                                                                                                     1.11481
.25224
.16272
                                         . 175
                                                                                                                                                                  COMPELATION COFFFICIENTS . 4546
    ORVERS 110CTF711LB, FULL BUPIERICPANGE ACEVLIC, 2 THEM CHAIFE PARTIES FULL STAPES STATE STAPES STATE STATES OF THE STATES OF THE
                                                                                                                                                 CRATER PARTUS (RC)+ -622 HETERS
                                                                                                                        ----POSTSHOT PELL
PACE
HETERC
9.484 15.4016
4.770 7.6641
1.353 2.1743
                                                                                                                                                                  1.18756
.88446
.73737
                                       .177
                                                                                       -.43499
                                         . 189
     137 3 PTT TO LOS-LOS POUATION (R/RC) = .362*(1/RC) ** -2.747
                                                                                                                                                                    CORRELATION CORFFICTENTY .9899
```

Table A2. Preshot and Postshot Distances of Individual Pellets (Cont)

FIELD DATAL	OF GURIA	1 2.5	GRFFN GLASS 404		CRATE	
FIELC DATAI	P	ESHOL PELL	ET RANGES		SHOT PELL	FT RANGES
	×	X/4C	L06101X/PC	, •	R/RC	LOGIO (R/RC)
	HETERS			RETERS		
	.152	. 2449	61109	24.613	79.5446	1.59709
	.229	. 36 7 3	43499	9.987	16.0387	1.20516
	. 305	. 4497	11006	4.000	6.4398	.80887
	. 30 1	.6121	21315	. 699	1.4447	±19977
.ST 50 PIT TI		FOURTION	(8/80)=	. 388*(1/40) **	- 3. 452	CORPELATION COFFEICTERTS
DEVENS 1100TH	/312L9,FU	i t dimilin:	FFR AGRYLTO	,1 THCH	CPATE	R PADIUS(RC) + .A41 METERS
PELLET DEPTH	OF MURIA	2,5	LCH			
		EZMCI BELL	FT RANGES		SHOT PELL	ET RENGES
FIELD CATAL	¥ Meters	1/RC	FUCTUENTEC) P	P/RC	LOF18(R/RC)
	ME IF W?			HETERS		
	. 305	.3623	44091	48.615	57.7899	1.76185
	. 181 .457	.4520 .5495	34400	25.904	30.7971	1.48851
	.999	4741	26482 19787	13.040	14.3116	1.15569
	610	,7744	1 1988	2.44# 1.852	7.9094 1.2500	.96571 .09691
ST 50 FET TO	1 606-606	EGN#110H	(R/ ?C) =	. 75 (* (*/RC)**	-5.692	COPRELATION COEFFICIENT# .9
	-					
EVENS 110CT / FLLET DEPTH	CF THOTA	L = "."	F C M			R PACTUS (PC) = . 841 METERS
		EZHOT BELL	FT PANGES	757	SHAT PELL	ET RENGES
TELD DATAS	¥	1/00	FORTALEN+C	, •	9/95	LOGIO (P/PC)
	METERS			HFTEDS		
	.229	.2717	-, 46585	48.984	46.3406	1.66596
	. 305	.3623	66791	16.7 %	19.8913	1.29866
	. 161	.45?9	34490	4.321	9.8911	.99525
	.457	.5435	75487	1.211	1.8486	.58440
ST SO FIT TO	106-106	EQUATION.	(P/9C)=	.524*(4/00)**	-1,503	COFRELATION COFFECIENTS .9
EVENS 110577 ELLET DEPTH	OF SUPTAI	2.50	CM			R RADIUS (RC) = .AN1 METERS
TELO DATA:	¥		T PANGES			FT PARGES
1460 04141	HETFPS	*/**	(maint syst)	457685	R/RC	FULL CLASSO
	705	.362*	5 5 7 9 1			
	361	4520	14400	46.437	A7.6817	1.83847
	.457	9635		27.144	26.3225	1.42033
	.533		26482	7.274	5,4 770	.93384
	.610	.6341 .7246	19747	4.054	4.8188	. 68294
		• • • •	17988	1.875	*.2781	. 14797
31-31 FIT TO	100-106	£0:184 £0#	(R/RE)=	. 478*(4/40) **	-4.941	COPRELATION COFFFICIENTS 1299
E VENS 110CF 7	31769.44	F-PUB 16 N1	En Aceyilo.	. THE	COATE	R RADIUS(PC)= .737 HFTERS
ELLET DEPTH	AE	- 2 61	PM			
	1	SHOT PELLI	7	POSTS	SMOT PELL	et panges
TELO DATAT		X/QC	L0010 (27FC)	0	0/9C	LOG10 (P /PC)
,	HFTERS			HETCOS		
	.15?	.2069	64431	45.461	61.7887	1.79035
	.229	.3105	50927	21.717	29.4787	1.46451
	. 305	.4137	75126	4.743	11.8535	1.07385
	. 78 1	.7177	28437	4. 727	6. FR1 B	. 624.99
	.457	.4276	70719	1.494	2.0273	.30692
	. 535	. 7249	14024	.975	1.3248	•121A7
	.610	.7241	14024	, 797	1.0757	.12187 .03170
ST 50 FLY TO	.610	.7241	00225	.975 .797	1.0757	.03170
ST 90 FIT TO	.533 .610 LOS-LOS	. FZ44 .62 FF EQUÁTION	8622F {R/9F} =	,797 ,5919(¥/RA)++	1.0757	.03170
EVENS 110017	.533 .618 LOG-LOG	. 7249 .827F EDUATION F-FURTERIC	-,8822F {R/9C} x EBNGF BCFY1	,797 ,5919(¥/RA)++	1.0757	.03170
ST SQ FIT TO EVENS ILOUT? FLEET DEPTH (.533 .610 LOG-LOG 317L5,MAL 35 RIPTAL	.7249 .627F EDUATION F-FURTEDIC = 5,88	06225 (R/97) =	.797 .591*(Y/Re)** [G,? [404	1.0757 - 1.146 - CPATF®	.03170 CORPCLATION COEFFICIENT* .48
EVENS 1100177	.533 .610 LOS-LOS SIRLS, MAL OF GUPTAL	.7249 .627F EDUATION F-FURTED:C = ", OF SHOT FELLE	-,0027F (R/9F) # FANGE BORY) FANGE S	.792 .591*(Y/RM)** IG,7 IYOY PNSTS	1.0757 -1.146 	.03170 CORPCLATION COFFFICIENT: .48 PANTHSCHOOL: .737 WETERS T PANGES
EVENS 110°T7' FLLET DEPTH (.535 .610 LOG-LOG STRLS, MAL SF RIPPAL	.7249 .627F EDUATION F-FURTED:C = ", OF SHOT FELLE	06225 (R/97) =	.792 .59**(*/R*)** TG,** I404 PA**S	1.0757 -1.146 	.03170 CORPCLATION COEFFICIENT* .48
EVENS 110FT?	.535 .610 LOG-LOG STRL5, MAL OF RIPPAL 	.7249 .827F EDURTION F-FURTEDIC TONP SHOT FELLE X/BC	-,0827F (R/9F) = EANGE ACEVI FM T EANGES (OCIT(Y/FG))	.792 .591*(*/Re)** TO,? 1404 	1.0757 -1.146 CRATTO HOT OFFLE RANG	.03170 CORPCLATION COFFFICIENT* .98 PANTHSCROIX .717 METERS T PANCES LCG10(0707)
EVENS 110FT?	.533 .610 LOG-LOG SITLS,WAL CF RIPTAL PPE WFTEPS .152	. FZ49 .02FF EDUATION F-FUPTFOIC # T, NP SHOT FLLLF K/PC .2869	-,8827F (R/9F) # EBNGF BFFY1 FM F EBNGE S LOF(MEY/FG) -,48471	.792 .5939(X/Re)** IG,* 1404 	1.0757 -1.146 	.03170 CORPCLATION COFFFICIENT* .98 PROTIIS(PO1 * .737 WETEPS ** PROTECT—
EVENS 110FT?	.533 .610 LOG-LOG STRLS, MAL OF RHIPPAL 	FZ49 .027F EQUATION F-FUPTFOIC # 5,0P SHOT FLLUF */PC .2869 .3103	-,0827F (R/9F) = EBNGF BOFY; FM T FANGE S (DOC10(*/FG) -,48471 -,58422	.797 .593*(Y/Re)** IG,* IHOH 	1.0757 -1.146	.03170 CORPCLATION COFFFICIENT* .98 PANTHSCROL* .737 METERS 7 PANCES LCG10(P)PC; 1.48771 .55875
EVENS 110FT?	.533 .610 LOG-LOG BITLS, MAL OF RIPPIAL 	.7249 .027F EQUATION F-FUPTFOIC = 5,0P SHOT FLLUF */#F .2869 .3103 .5137	-,0022F (R/90) # FANGE APPYL TH T FANGE 5 LOGIN(*/FG)48411508221872F	.792 .5939(X/Re)** IG,* 1404 	1.0757 -1.146	.03170 CORPFLATION COFFFICIENTS .98 PANTINSIDES .737 WETFPS T PANCES
EVENS 110FT?	.533 .610 LOG-LOG STYLS, MAL SF RIPTAL PPC H FFTERS .152 .229 .385 .381	.7249 .827F EQUATION F-FURTEDIC # 5,0P SHOT FLLLF */PC -2869 .3103 .4137 .5172	-,0027F IR/9F1 = EBNICE BCPV1 T EBNICE C LOCITEY/PC) -,58641 -,59822 -,1872P -,26637	.797 .593*(X/RP)** IC,7 IHON 	1.0757 -1.146 CRATTO HOT OFFLE 9/BC 10.7406 4.0939 3.7607 1.6127	.03170 ECRPCLATION COFFFICIENT* .98 PAGINGEGOUS PARTICLE .737 METERS T PANGEGOUS 1.64771 .55475 .41776 .25424
EVENS 110FT?	.533 .610 LOG-LOG STRLS, MAL DF RIPPIAL 	. F249 .027F EDUATION F-FUPTFOIC # C.PF SHOT FLLLF E/BC .2869 .3103 .4137 .5172 .6295	0022F (R/90) = FANGE ACEVI T FANGE C (DOINTY/PC) 58471 58472 1872F 2663F 27719	.797 .591*(Y/RP)** IC,** I40*	1.0757 -1.146 CRATTO HOT OFFLE 7/RC 30.7406 4.0939 3.7607 1.8127	.03170 CORPFLATION COFFFICIENTS .98 PANTINSIDES .737 WETFPS T PANCES
EVENS 110FT?	.533 .610 LOG-LOG STYLS, MAL SF RIPTAL PPC H FFTERS .152 .229 .385 .381	.7249 .827F EQUATION F-FURTEDIC # 5,0P SHOT FLLLF */PC -2869 .3103 .4137 .5172	-,0027F IR/9F1 = EBNICE BCPV1 T EBNICE C LOCITEY/PC) -,58641 -,59822 -,1872P -,26637	.797 .593*(X/RP)** IC,7 IHON 	1.0757 -1.146 CRATTO HOT OFFLE 9/BC 10.7406 4.0939 3.7607 1.6127	.03170 ECRPCLATION COFFFICIENT* .98 PAGINGEGOUS PARTICLE .737 METERS T PANGEGOUS 1.64771 .55475 .41776 .25424

Table A2. Preshot and Postshot Distances of Individual Pellets (Cont)

DEVENS 110CT7	31368.HAL	F-PURIFDIG	REFN GLASS,1	INCH		RADIUSINCIA .757 HETERS
PELLET DEPTH	OF BUNIAC	SHOT PELLE	CM 1 RANGES LOGISEY/RC)	POST	SHOT PELLE	T RANGES LOGI BIR/RC)
TETAL GUSTY	X _	X/ RC	CIRC SAL AN WITH	HETËRS		
	HETERS		-,58827	21,010	28,9188	1.45513
	.229	3105		7. 777	10.4882	1.02070
	. 305	.4137	-, 16328	9.538	8,8756	. 44 81 7
	. 70 1	.5172	28637	1.716	2,3293	. 26723
	.457	.6286	7 07 19	1.147	1.5715	.19875
	.953	.7240	14074	. 653	1.1585	.05784
	.618	.8275		.677		
LSY 50 FIT TO	106-106	FOURTION	(P/RG)= .	5849 (X/PC)**	- 3, 568	CORRELATION COEFFICIENT= .9795
	71:41 R . HAI	F-BURIFNIF	FC ACRYLICAL	TNCH	CRATER	PANIUS (RC) = .79% PETERS
DEVENS 110CT	OF BUPLA	2.54	ۥ			PANGES
P4464 40	PR1	SHOT PFLLF			SHOT PELLS	LOGISTA/ACT
FIELD DATAS	٧.	X/45	LOGISIX/PC)		P/RC	Chathan
LIECO DATE.	METERS			451685		1.6045
	.279	. 2885	54058	91.929	41.2266	
	30	. 3848	41564	17.574	27.1467	1.36531
	101			1.044	1,0402	.56475
	457	. 5760	> + 05,5	1, 161	4.74.95	.6277?
		6776	- 4 7760	1.082	1. 1631	. 13459
	.533	.7649	11461	.005	1.1405	.05712
	.617			-		AT YOU POT PETP LET - 873
LST 50 FTT T	c ton-ton	FOLATION	(1,130): •	469+(X/PC) **	-1,455	COPPELATION COEFFICIENTS . 972
		•				
-			CAUCT ACCALL	C.C INCH	COATE	# #ADTUS(PC) = "794 METERS
DEVENS 110CT	731669,44	L s — e'Wa Fenane Iinse	ranger witter			
PELLET DEPTH					SHOT PFLI	FT PANGES
	PP	FYMCI PELLI	T PANGES	•	R/ RC	LOGIOIPARCI
FIELD DATAL		4 \bt	further co	METERS		
	MF 1 FRS		*****	11.132	41.7435	1.62059
	.157	.192h	71667	10.254	21.0031	1.34179
	. > > 0	.2660		6.471	R. 5457	.76793
	175	. 2440	- 41 564	4.411	1.9278	.28506
	. 35 1	. 4#911	11873	1.519	1.2097	.09267
	,447	. 5 740	1955	.911	1.647	
137 30 FIT T	0 106-106	FOURT 1CH	(9/9C)= .	189+1 X/+C) *	-1.45#	COPRELATION COEFFICIENT# .978
						# WADIUSTROIT .79% WETERS
OFFENS 11007	731 BL R . HE	[# - PI F T F T	CRFFN GLA**.	I THUM		4 4301031401- 1/14
PELLET DEPTH						ET #ANGES
	PE	A JMOI PAPE	ET RINGES	P	9/40	LOGICER/OC)
FIELD DATAS	X	X/EC	CO010(X/EC)		4740	£1/10.1.0.1
	HP TV R C			46164		1.68755
	.274	9885	54958	14.655	HR.7020	1.01595
	. 104	. 35 4 6	61446	1.167	10.1 342	. #6815
	. 101	.44 9 ^	11/74	2.804	3.5530	• * • • • • • • • • • • • • • • • • • •
	447	. 5740	21955	7.240	2.8725	.45064
	.533		17250	1.161	1.6897	+227A1
	410	2443	11461	. 899	1.1 129	. 05417
•	1910	••••				CORPELATION COPPETCIENTS .98
497 50 FIT	7 C L OG-L0	C EQUATION	(0/RC) =	, 3470 (1/00) *	• -3.698	CORMECULICA COLLA POTENTA
-	7 797 SL # .H	at F=911# 1FD	PER ACPYLIC.	S INCH .	CRAT	FR PARTIUSTRUST .SAS METERS :
PELLET OFPT						LET MANGES
		BF5H01 #4L1	LEE MANGES	PC.	112MOL PER	LOCIGER/PC)
PIELO GATAL	¥	X/BC	LUCTULATED		R/PC	FOUTOTALERS
A TECH GRIAG	HF TERS			WEIFEL		
	.152	.7711	5 5 6 7 5	19,671	20.5803	
	12.6	4897	19776	9, 177	16.2471	1.21978
		4471	24576	1.64	2.9191	. 46874
	. 50 5	6775	1 5 665	.615	1.0954	, p3049
	• • •			. 190***/*()	** -4.676	COMPRESTION COFFFICTENTS . 49
LST SQ FIT	14 too-to	ar Chini (na	1			
			IDRAHGE ACEVI	TELS THEN	CRAT	PRIFFE TAP (DR) PUIDAN RT
PELLET GEPT						
PELLET DEPT	- UT 7071	DE SHET BEL	LF ! BANGES		SISHOT PEL	LET BANGER
		7 1 JAC 941	LOGIOLY/PCI		R/VC	LOGIER PC1
FIELD DATES		E/ 41		4511.05		
****	HFT795		56679	4.517	4.0365	.90%0*
	,152	. 2711		1.494	9.0204	. 46 ft ft
	.224	.4847	19878 26476	1.091		
	.105	15421	16465	. 646		. 06057
	, 101	.6779	- *10=0,			
	7g 100-L		(#/#61#	*#####################################	** -2.077	CORRELATION COMPRICIONS 199

Table A2. Preshot and Postshot Distances of Individual Pellets (Cont)

PELLET DEPTI	PR	ESHCT PELLI	T RANGES	POST	SHOT PELLE	T RANGES		
PIELO DATAT	··· X	X/RC	LOGIO (X/RC)		R/RC	LOGIDIR/RC)		
	METERS			METERS				
		.2711	-,56679	21.580	38.3948	1.58427		
	•229	.4067	39070	8.111	14.4306	1.15928		
	.305		-,26576	3.859	6.8655	•E3557		
ST SU FIT 1	ront acut ac	COURT TON	/P/901= 4	.523*(X/RC)**	-2 5.70	CODDE! STIAN	CGEFFICIENT=	- 000
	10 200 200	240-11011	107-07- 1	* >5 3 - (W) KO3	- () 4/)	OURKELATION	OULT TOTEMI-	• • • •
			PED-ACRYLIC.					
PELLET DEPTH				1 INCH	CRRIE	RADIUS(RC) =	. LIA WEIEK2	
	******	ESHOT PELL	FT RANGES	POST	SHOT PELLE	T PARGES		
TELO DATA:	x	×/RC	LOGID(X/PC)		R/RC	LOGIO(R/RC)		
	HETERS			METERS				
	• 55 9	.3181	49748	20.*77	28.9779	1.46207		
		.4241	37254	10.353	14.4190	1.15894		
	. 36 1	.5301	27563	4.679	6.5098	. 81 7 56		
	. 457 .533	.6361 .7422	19645 12951	2.597	3.6132 1.5479	.55790 .16975		_
	• > 3 3	*****	-116 331		1.94.5	*10313		
ST SQ FIT 1	rc LoG~LoG	EQUATION	(R/RC)=	.689*(X/RC)**	-3.392	CORPELATION	COFFFICIENT=	• 990
			-	•				
			PRANGE ACRYL	IC.2 INCH	CRATER	RADIUS (PC) =	.719 HETERS	
ELLET DEPTI								
TENU DATAL		E SHCT PELLI	ET RAYGES LOGIO(X/PC)	P051		T RANGES		
TENO DATAL		X/ H1	LIGIBLATE.)	METERS	RIRC	LOGITRAPCI -		
	HETERS 152	.7120	67357	2.015	2.8032	,14756		
	.229	3181	49748	1.926	2.6802	.42817		
	.305	.4241	37254	1.509	2.0992	.32286		
	- 38 1	.5301	27563	1.402	1.9508	.29021		
·	.497	-6301	19645	.961	1,3359	12577		
37 30 FI T 1	L L L L L L L L L L L L L L L L L L L	FOOTITON	(K/4C) = 1	. 178*{ \/OC} +0	674	CORRECALION	CHEFFICIENT	
TELD DATAT	X	X/RC	T PANGES	R	R/RC	T PANGES LOG10(P/PC)	•	
	HETFRS			HETERS				
	•559	.7151	49748	28,383	39.4911	1.59650		
	•361	** .4241 •5301	57754	16.511	22.3729	1.36127		
• .	.457	.6361	27563 19645	4.511 1.555	6.2765 2.3024	.79772 .36226		
	.533	.7422	12951	.927	1.2892	.11033		
ST SQ FIT 1	0 106-106	EQUATION	(R/QC)=	.383*(X/RC)**	-4.288	CORRELATION	COEFFICIENT=	. 983
								
DEVENS 1600. PELLET DEPTI	7313L8,FU	LL 911FJFD11 L = 7.51	FID ACRYLIC,	1 IVCH	CRATER	PACIUS (PC) =	913 HETFPS	
CERCI OCPII			FT RANGES	Pnst	SHOT PFLLE	T PANGES		
TELO DATAT	X	X/RC	FU214(X\60)	P	R/RC	LOGIC(P/PC)		
	HETFFS			HETERS				
•	.381	.4174	37949	24.775	27.0851	1.43273		
	.457	.5008	30031	13.497	14.7846	1.16981		
	.531	.5841	23336	5,590	6.1235	.78700		
	-610	.6678	17537	3.280	3.5927	.55542		
•	.686	.7513	12421	1.366	1,4958	.17458		
	.762	.8347	17846	.972	1.0651	. (2739		
LST SQ FIT 1	TO LOG-LOG	EQUATION	(8/80)=	.440*(X/RC)**	-4.870	COPRELATION	COFFFICIENT=	. 99
						•		
			OFANGE ACFYL	IC.2 INCH	CRATE	RACTUS(RC) =	.913 HETFRS	
	A OF SURIA	L = 5.00 ESHOT PELLI	PCH FT PLNGES		SHOT PELL	T PANGES		
PECTEL DEMI		X/RC	FORTO (XVBC)		R/RC	LOGITIR/RC)		
	X			HETFOS				
	HETERS •305	.3339	47640	17,136	18.7713	1,27349		
	HETERS	.3339 .4174	47640 57949	7.934		1.27349 .93908		
	HETERS .305 .381 .457	.4174	37949 30831	7.934 5.803	8.6912 6.3573	1,27349 ,93908 ,80327		
	HETERS .305 .381 .457 .533	.4174 .5088 .5843	-,37949 -,30031 -,23336	7.934 5.801 3.65A	8.6912 6.1571 4.0067	.93908 .80327 .60278		
	HETERS .305 .361 .457 .533	.4174 .5088 .5843	-,37949 -,30031 -,23336 -,17537	7.934 5.803 3.65A 1.981	8.6912 6.3573 4.0067 1.6227	.93908 .80327 .60278 .21024		
	HETERS .305 .381 .457 .533	.4174 .5088 .5843	-,37949 -,30031 -,23336	7.934 5.801 3.65A	8.6912 6.1571 4.0067	.93908 .80327 .60278		
PIELO DATAT	METERS .305 .381 .457 .533 610 -	.5174 .5088 .5843 -6878 .7513	-,37949 -,30031 -,23336 -,17537 -,12421	7.934 5.803 3.65A 1.981	8.6912 6.4574 4.0067 1.6227 1.3890	.93908 .80327 .60278 .21024 .14270	COEFFICIENT*	

Table A2. Preshot and Postshot Distances of Individual Pellets (Cont)

FEELO OATAT	.000	COURT BELLS	T PANGES			ET PANSES	
		X/#C	LOGIO (X/PC)	R		LOG18(P/RC)	
	HETERS			METERS			
	. 305		*********		98.9589		.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
	.361	.4174 .5008	37949 40631	21.198	23,2120 13,3022	1.36571 1.123 9 2	
	.457 .533	•5843	23336	12.143 7.541	8.2604	.9170	
	.610	.6678	17537	3.405	3,7295	.57166	
	.686	.7513	12421	1.301	1.4257	.15403	
	-767	.8347	07846	1.073	1.1753	.07015	
191-30 FIT T	0 £0G-£0G	EQUATION	(R/RC)= .	493+ (X/RC)+	-4.701	CORRELATION CO	EFFICIENT= 49913

DECET DEPTH	OF SURTAL	. = 7.5				P PADTUS(RC)=1.01	S METERS
FIELD DATAL	hki	X/8C	FT RANGES Log10(Y/PC)	F0S		T FANGES	
TECH ONTHE	MFTÉRS	.,	(43101.1.01	METERS	K/KC	LOCID(P/PC)	
	. 385	.3009	52153	59.954	59.1935	1,77227	
	.457	.4514	34544	24.636	28.2726	1.45137	
		•5256	27849	17.887	12.7234	1.10450	
	. 610	.6019	22050	4.:70	4.1168	·61456	
	.686	.6771	16935	3.085	3.0454	.48365	
	.762 .818	,7523	-•12*59 -•98*20	1.676	1,6551	. 21 887	
	• 616	.8276	58-20	1.113	1.0984	.04076	
ST SU FIT T		EQUATION	-(P/9C1= .	=880 (X\bC) 44	-4.194		EFFICIENTE - 9732
DEVENS 160CT	73:4LR,FUL		RANGE ACRYLI	C+S INCH	CRATE	R PADIUS (RC) =1.01	3 HETERS
PELLET DEPTH			RCH 'T RANGFS		SHOT DELL	T RANGES	
FIELD DATA:	×	X/RC	LOGIO (X/PC)	R		LOGIO(R/RC)	
	HETERS			METERS			
	. 375	.3009	52157	22.065	21.7875	1.33821	
	+ 38 1	.3762	42462	16.374	16.1661	1.20861	=
	. 457	.4514	34544	9.077	8.9618	.95239	
	:233	.5266	-,27849	4.053	7.9506	40040	
	.610	.6019 .6771	**22058	5.428	6.3467	.88255	
-	•686 •762	.7523	16935 12359	1.768	1.7454	.24198 .07065	
	*****	******	*******	1.170	1.1.60	*07007	
PELLET DEPTH	OF BURIAL	. = 2.56				R PADTUS (RC) =1.01	S HETERS
	PRE	SHCT PELLI	T RANGES			T RANGES	
TELO DATAT	HETERS	····XFRC	L0610 (X/RC)	. W HETERS	R/RC	LCG18(R/RC)	
	•301	.3762	42462	43.983	41.4246	1.63774	
	.457	.4514	34544	26.953	26.6115	1.42507	
	.533	.5266	27849	13.777	13.6022	1.13361	
	-618	.6019	22050	7.202	7.1110	.85193	
	688	.6771	16935	4.420	4.3635	.63984	
	. 762	.7523	12359	1.439	1.4204	.15241	
	.838	.827E	08220	1.073	1.0593	.02501	
	.914	.9028	04441	1.179	1.1556	.06780	
ST SQ FIT T	C LOG-LOG	EQUATION	(R/RC) = .	565* (X /nc) * *	-4.685	CORRELATION CO	FFICIENT= .9840
TEVENS 160CT				INCH (REPRO	UC) CRATE	RACIUS(RC) = .70	HETERS
	OF SUPLAL						
PELLET DEPTH	PRE	SHOT PELLE	T RANGES			T RANGES	
PELLET DEPTH	PRE	SHOT PELLE	T RANGES Login(X/RC)	R		T RANGES Log10(R/PC)	
PELLET DEPTH PIELO DATA:	PRE	SHOT PFLLE	F0210 (X/60)	R Meters	R/RC	LOG10(R/PG)	
PELLET DEPTH PIELO DATA:	HETERS	SHCT PFLLE X/PC .2167	LOGIO (X/RC) 66408	R METERS 33,739	R/RC 47.4122	LOG10(R/PG)	
PELLET DEPTH PIELO DATA:	HETERS	:SHCT PFLLE X/PC .2167 .3251	LOGIO (X/PC) 65408 48799	R METERS 33.739 28.072	47.4122 39.9220	1.67589 1.60121	
PELLET DEPTH PIELO DATA:	PRE X METERS .152 .229 .305	**************************************	LOS10 (X/RC) 65408 48799 36705	R METERS 33.739 28.072 12.893	R/RC 47.4122 39.9228 18.3355	LOG10(R/PC) 1.67589 1.60121 1.26329	
PELLET DEPTH PIELO DATA:	PRE X METERS .152 .229 .305 .381	**************************************	LOS10(X/RC)55408487993670526614	R METERS 33.739 28.072 12.893 4.907	R/RC 47,4122 39,9220 18,3355 6,9788	1.67589 1.60121 1.60121 1.26324 .84378	
TELO DATAS	PRE X METERS .152 .229 .305	**************************************	LOS10 (X/RC) 65408 48799 36705	R METERS 33.739 28.072 12.893	R/RC 47.4122 39.9228 18.3355	LOG10(R/PC) 1.67589 1.60121 1.26329	
PELLET DEPTH	PRE X METERS .152 .229 .305 .381 .457 .533	.2167 .2167 .3251 .4335 .5418 .6502 .7586	LOGIO (X/RC)664084879936705266141869612001	R METERS 33.539 28.072 12.893 4.907 1.189	R/RC 47.4122 39.9220 18.3355 6.9788 1.6905 1.7945	1.67589 1.60121 1.60121 1.26329 .84378 .22802 .25395	
CELLET DEPTH	PRE X METERS .152 .229 .305 .381 .457 .533	2167 .2167 .3251 .4335 .5418 .6502 .7586	66408 48749 76705 26614 18696 12001	R METERS 33-739 28-072 12-893 4-907 1-189 1-262 872*(*/RG)**	R/RC 47,4127 39,9220 18,3355 6,9788 1,6905 1,7945	1.67589 1.60151 1.26527 .84378 .22802 .25395 CORPFLATION CO	EFFICIENT* •9382
PELET DEPTH PIELD DATA: LST SQ FLT T	PRE METERS .152 .279 .305 .381 .457 .533 0 LOG-LOG	SHCT PFLLE X/PC .2167 .3251 .4325 .5418 .6502 .7586 EQUATION	66408 48749 48749 16614 18696 12001 (R/RC) = .	R METERS 33.139 28.072 12.893 4.907 1.189 1.262 872*(*/RG)**	R/RC 47,4122 39,9220 18,3355 6,9788 1,6905 1,7945 -2,980	1.67589 1.6021 1.26329 .84378 .22802 .25395 CORPFLATION CO	EFFICIENT* •9382
PELCET DEPTH PIELO DATAT LST SQ FLT T DEVENS 160CT	PRE METERS .152 .229 .305 .381 .457 .533 0 LOG-LOG .7312LB,FULPRE	SHCT PFLLE X/PC .2167 .3751 .4325 .5418 .6502 .7586 EQUATION LL BURIED:: = 5.00	6640R 46799 16705 26614 18896 12001 (R/RC) =	R HETERS 33.739 28.072 12.893 4.997 1.189 1.262 872*(X/RG)*** C,2 INGH(REI	R/RC 47,4122 39,9220 18,3355 6,9788 1,5905 1,7945 2,980 PROD) CRATE(1.67589 1.60121 1.26329 .84378 .22602 .25395 CORPFLATION COI	EFFICIENT* •9382 3 HETERS
PELCET DEPTH PIELO DATAT LST SQ FLT T DEVENS 160CT	PRE METERS .152 .259 .305 .351 .457 .533 0 LOG-LOG 7312LB,FUL 1 OF BURIALPRE	SHCT PFLLE X/PC .2167 .3751 .4325 .5418 .6502 .7586 EQUATION LL BURIED:: = 5.00	66408 48749 48749 16614 18696 12001 (R/RC) = .	R METERS 33, 139 28,072 12,893 4,907 1,189 1,262 877* (x/RG)** C,2 INGH(REIPOSI	R/RC 47,4122 39,9220 18,3355 6,9788 1,5905 1,7945 2,980 PROD) CRATE(1.67589 1.6021 1.26329 .84378 .22802 .25395 CORPFLATION CO	EFFICIENT* •9382
PELLET DEPTH PIELD DATAT LST SQ FLT T DEVENS 1600T PELLET DEPTH PIELD DATAS	PRE X METERS .152 .229 .305 .361 .457 .533 0 LOG-LOG 7312LB,FUL 1 OF BURIALPRE METERS	SHCT PFLLE X/PT 2167 .3251 .4325 .5414 .6502 .7586 EQUATION L BURITON L BURITON L SURTEDN 25.01	-56408 -44799 -16705 -26614 -18696 -12001 (R/RC) x	R HETERS 37.739 28.072 17.893 4.997 1.189 1.262 87?*(X/RG)** C,2 INGH(REIPOST R HETERS	9/RC 47.4122 39.0220 18.3355 6.9788 1.6905 1.7945 -2.980 PROD) CRATE	LOGIO(R/PG) 1.67589 1.60121 1.26329 .84378 .22802 .25395 CORPFLATION COI R RADIUS(RC) = .70 ET PANGES LOGIO(R/RC)	EFFICIENT* •9382 3 HETERS
PELLET DEPTH PIELD DATAT LST SQ FLT T DEVENS 1600T PELLET DEPTH PIELD DATAS	PRE X METERS .1229 .305 .301 .497 .533 O LOG-LOG .73; 2L8,FUL 1 OF BURIALPRE METERS .152	SHCT PFLLE X/PT .2167 .3251 .4325 .5418 .6502 .7586 EQUATION L BURITON L BURITON L BURITON 2.167 .2167	56408 4779 56705 26614 18596 12001 (R/RC) x	R HETERS 33, 139 28,072 12,893 4,907 1,189 1,262 872*(X/RG)** C,2 INGH(REIPOS' R HETERS 11,663	9/RC 47.4122 39.0220 18.3355 6.9788 1.6905 1.7945 -2.980 PROD) CRATFO SHOT PELLO	1.67589 1.6021 1.26329 .84378 .22802 .25395 CORPFLATION COI R RADIUS(RC) = .70 T PANGES LOGIO(R/RC) 1.22713	EFFICIENT* •9382 3 HETERS
PELLET DEPTH PIELD DATAT LST SQ FLT T DEVENS 1600T PELLET DEPTH PIELD DATAS	PRE X METERS .1229 .305 .301 .497 .533 O LOG-LOG .73; 2L8,FUL 1 OF BURIALPRE METERS .152	SHCT PFLLE X/PT .2167 .3251 .4325 .5418 .6502 .7586 EQUATION L BURITON L BURITON L BURITON 2.167 .2167	56408 4779 56705 26614 18596 12001 (R/RC) x	R METERS 33,739 28,072 12,893 4,907 1,189 1,262 872*(X/RG)** C,2 INGH(REIPOSI R METERS 11,863 3,011	9/RC 47.4122 39.0220 18.3355 6.9788 1.6905 1.7945 -2.980 PROD) CRATE	1.67589 1.6021 1.26329 .84378 .22502 .25395 CORPFLATION COI R RADIUS(RC) = .70 TY PANGES LOGIO(R/RC) 1.22713 .63171	
PELLET DEPTH PIELD DATAT LST SQ FLT T DEVENS 1600T PELLET DEPTH PIELD DATAS	PRE X METERS .152 .229 .305 .381 .457 .533 O LOG-LOG .73; 2LB, FULL .0F SURIALPREPRE .172 .229 .331	SHOT PFLLE X/PT .2167 .3251 .4325 .5418 .6502 .7586 EQUATION L BURILDII # 5.01 SHOT PFLLI X/RC .2167 .3251 .4335	LOGIO (X/PC)5640846749365105266141869612001 (R/RC) x	R HETERS XX, T39 28.072 17.893 4.907 1.189 1.262 872*(X/RG)** C,2 INGH(REIPOST R HETERS 11.663 3.011 1.85%	R/RC 47.4122 39.0220 18.3355 6.9788 1.6905 1.7945 -2.980 PROD) CRATF(SHOT PELLI R/RC 16.6704 4.2826 2.3734 2.0069	LOGIO(R/PG) 1.67589 1.6021 1.26329 .84378 .22802 .25395 CORRELATION COI R RADIUS(RC) = .70 TY PANGES LOGIO(R/RC) 1.22713 .63171 .36612 .305753	EFFICIENT* •9382 3 METERS
PELLET DEPTH PTELO DATA:	PRE X METERS .152 .229 .305 .381 .457 .533 O LOG-LOG 731 2LB,FUL OF BURIALPRE X METERS .172 .229 .369	SHOT PFLLE X/PT .2167 .3251 .4325 .5418 .6502 .7586 EQUATION L BURILDII # 5.01 SHOT PFLLI X/RC .2167 .3251 .4335	56408 4779 16707 26610 126610 12601 (R/RC) * . **********************************	R HETERS 33, 339 28,072 12,893 4,907 1,189 1,262 872*(x/RG)** C,2 INGH(REIPOS' R HETERS 3,011 1,653	R/RC 47.4122 39.0220 18.3355 6.9788 1.6905 1.7945 -2.980 PROD) CRATF(SHOT PELLI R/RC 16.6704 4.2826 2.3734 2.0069	LOGIO(R/PG) 1.67589 1.6021 1.26329 .84378 .22802 .25395 CORRELATION COI R RADIUS(RC) = .70 TY PANGES LOGIO(R/RC) 1.22713 .63171 .36612 .305753	EFFICIENT* • 9382 3 HETERS

Table A2. Preshot and Postshot Distances of Individual Pellets (Cont)

PELLET DEPTH	 	SHCT PFLLE	T RANGES	6021		T RANGES	
FIELD DATAL	x	X/RC	LOS10(X/PC)	R	R/RC	LOG19(R/RC)	
	HETERS			HETERS			
	-229	.3251	48799 :383 09	30.419 13.991	43.2596 - 19.8596 ·	1.63688	
	.361	- 14339 - -5418	26614	5.206	7.4836	.86944	
	.457	.6502	18696	1.603	2.2600	.35794	· · · · · ·
				476* (X/RC) **	-4 170	CORRELATION CO	EFFICIENT: . 9015-
31 5 0 FIT T	0 100-100	EUUATION	(#/40/# *	4/6-62/20/	-4.177	CORRECTION OF	
EVENS SAPRI	L7415LB1S0	008=0.20:R	e ACRYLIC. 2	THCH	CRATE	PACTUS (RC)=1.02	4 HETERS
ELLEY"DEPTH	OF BURILL	10 T. 6	T RANGES	0051	SHOT PELL	T RANGES	
TELO DATAL	X		LOGIO (X/PC)	R	R/RC	LOGIO(P/PC)	
1000	METERS		•••••	HETERS			
	-305	.2976	52634	46.310	39.3601	1.59506	
	.381	.3720	42943	17.983	17.5595	1.24451	
·	.457	. 4464	15075	9.098	8.8839	.94851	
	.533	•5288	58330	7.199	7.0298	.84694	
	.618	.5952	22531	5.502	5.3720	.73014	
_	.686	6696	17416 12848	1.539 1.204	1.5030 1.1756	.17695 .07026	
-	•762	.7446					
.ST 50 FIT T	C-106-106	ENTATION	- 16\dC)* .	.473*(X/BC)**	-3.725	COPPELATION C	OEFFICIENT= .9735
						,	
EVENS SAPRI	CF GURIA	L= 3.6	ELLOW GLASS, NCY			RADIUS(RC)=1.0	24 HETERS
	=4+PP	ESHOT PELLI	IT RANGES	PQS1	TSHOT PFLL	T RANGES LOGIO (R/PC)	
FIELD DATAS	#EXCO.	* Y/RC	LOGIO(X/PC)	HETERS	#/WC	L0010 (R/PC)	
	METERS	.3720	42947	20.955	20.4613	1.31093	
	.381	.4464	75025	10.982	10.7232	1.03032	
	.457 .533	.520A	28330	5.081	4.9613	.69560	
	,518	.5952	22531	1.222	3, 1458	49774	
	.686	.6696	-,17416	1.442	1.4077	.14852	
	0 t0G-t0G			,270*(¥/RC)* ¹		- •	OEFFICIENT = .9939
DEVENS JAPRI PELLET DEPTH	L74 SL8 S	 DOB=0.2010 L = 3.6 ESHCT PELLI	PANGE ACRYLIC FCM ET RANGES	:, 3 INCH	CRATE TSHOT PFLL	R RADIUS(PC)=1.6	
DEVENS JAPRI PELLET DEPTH	L7415LB1SI OF BURIAL PPI X	008=0.2010 L = 3.6 ESHCT PELLI X/RC	PANGE ACRYLIC	:, 3 INCH 	CRATE TSHOT PELL R/RC	R RADIUS(PC)=1.6 ET RANGES LOGIO(R/RC)	24 METERS
DEVENS JAPRI PELLET DEPTH	L7415LB1SI OF BURIAL PPI X	008=0.2010 L = 3.6 ESHCT PELLI X/RC	PANGE ACRYLIC FCM ET RANGES	1, 3 INCH 	CRATE TSHOT PELL R/RC 71.4782	R RAD JUS (PC) =1.6 ET RANGES LOG 10(P/PC)	24 METERS
DEVENS JAPRI PELLET DEPTH PIELD DATAS	L74 SL8 S OF BURIAN PP X MFTEPS 309 381	DOB=0.2010 L = 3.6 ESHCT PFLLI X/RC 2976 .3720	PANGF ACRYLII FCH ET RANGES LOGIO (XFPC) 52674 42943	0, 3 INGH 	CRATE TSHOT PFLL R/RC 31.4782 16.7798	R RADJUS(PC)=1.0 ET RANGES= LOG10TR/PC) 1.49790	24 METERS
DEVENS JAPRI PELLET DEPTH	L7415LB1SI OF BURIAL PPI X MFTEPS 385 381 457	008=0.2010 L = 3.6 ESHCT PELL X/RC 2976 -3720 -4464	PANGE ACRYLIC FCM ET RANGES LOGIO (X/PC) > 5765% 42943 35025	2, 3 INCH 	CRATE TSHOT PELL R/RC 31.9702 16.7798 6.3571	R RAD3US(PC)=1.6 ET RANGES LOG10TR/PC) 1.49790 1.22479 .82206	24 METERS
DEVENS JAPRI PELLET DEPTH PIELD DATAS	L74 5L8 S OF BURIA PP X METEPS 	008=0.2010 L = 3.6 ESHCT PFLL X/RC 2976 .3720 .4464 .5266	FANGF ACRYLIC FCM FT RANGES LOG10 (XFPC) 52674 42943 35025 28330	3 INCH 	CRATE TSHOT PFLL R/RC 31.4782 16.7798	R RADJUS(PC)=1.0 ET RANGES= LOG10TR/PC) 1.49790	24 METERS
DEVENS SAPRI PELLET DEPTH PIELD DATAS	L7415L81SI OF BURIA 	008=0.2010 L = 3.6 ESHCT PFLLI X/RC 2976 .3720 .4464 .5262 .5952	FANGF ACRYLIC FCM {1 RANGES LOG10 (X/PC) 57674 42943 35025 28330 22531	1 1 NGH 	CRATE TSHOT PFLL Q/RC 31.4702 16.7798 6.3571 3.8720 3.1667	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.49790 1.22479 .92206 .55794 .50060	24 MEYERS
DEVENS SAPRI PELLET DEPTH PIELD DATAS	L7415L81SI OF BURIA 	008=0.2010 L = 3.6 ESHCT PFLLI X/RC 2976 .3720 .4464 .5262 .5952	FANGF ACRYLIC FCM {1 RANGES LOG10 (X/PC) 57674 42943 35025 28330 22531	3 INCH 	CRATE TSHOT PFLL Q/RC 31.4702 16.7798 6.3571 3.8720 3.1667	R RADJUS(PC)=1.6 ET RANGES LOG10(R/PC) 1.49790 1.22479 .ezzoc .55794	24 MEYERS
DEVENS JAPRI PELLET DEPTM PIELO DATAF	L74;5L8;SI OF BURIAL THE PS 	008=0.2010 L = 7.6 E SHCT PFLU X/RC 	FANGE ACRYLIC FCM F1 RANGES LOGIO(X/PC) 576243 35025 28330 22531 (P/RC) =	1, 3 INCH REFES 17-785 C+159 3,456 3,456 3,456 3,456 3,456 3,456 3,456 3,456 3,456	CRATE TSHOT PFLL R/RC 31.9702 16.7798 8.3571 3.8720 3.1667	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) T.49790 1.22479 .92206 .58794 .50060	24 MEYERS
DEVENS JAPRI PELLET DEPTM PIELO DATAT LST SQ PIT T	L74 5LB S OF BURIAN WETEPS -305 -305 -305 -305 -305 -618 O LOG-LOG	DOB=0.2010 L = 3.6 ESHCT PFLU X/RC 	FANGE ACRYLIC FCM FT RANGES LOGIO(XFPC) 57678 42943 35925 281330 22531 (P/RC) = FC ACPYLIC: 3	3 INCH	CRATE TSHOT PFLL R/RC 31.4702 16.7798 8.3571 7.8720 3.1667 -3.515	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.42479 .02206 .58794 .50060 COPPELATION C	24 MEYERS
DEVENS JAPRI PETLET DEPTH PIELO DATA: 	127415LB1SI OF BURIAN TO BURIAN WETEPS 1301 1533 1519 10 LOG-LOG	DOB=0.2 PTO) = 3.6 E SACT PFLLI	FANGE ACRYLIC FCM 11 RANGES LOGIO (X/PC) 	# 3 INCH # # 1 FP 5	CRATE TSHOT PFLL Q/RC T1.4702 16.7798 6.3771 7.8720 3.1667 * -3.514 CRAIF	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.49790 1.22479 -2206 -58794 -50060 COPPELATION C	24 MEYERS
DEVENS JAPRI PETLET DEPTH PIELO DATA: 	L7415LB1SI OF BURIAN WHTEPS .381 .457 .533 .619 O LOG-LOG	DOB=0.2010 L = 3.6 ESHCT PFLU X/RC 	FANGE ACRYLIC FCM FT RANGES LOGIO(XFPC) 57678 42943 35925 281330 22531 (P/RC) = FC ACPYLIC: 3	2, 3 INCH	CRATE TSHOT PFLL Q/RC T1.4702 16.7798 6.3571 7.8720 3.1667 • -3.514 CRATE	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.42479 .02206 .58794 .50060 COPPELATION C	24 MEYERS
DEVENS JAPRI PEELET DEPTH PIELO DATA! LST SQ FIT T DEVENS JAPRI PELLET DEPTH	L74 5LB S OF BURIAN WETEPS -389 -381 -57 -533 -619 O LOG-LOG L74 SLB S G F BUPIA 	008=0.2010 L = 7.6 E SHCT PFLU X/RC 	FANGE ACRYLIC FCM FT RAGES LOGIO(X/PC) 57678 42943 35025 28730 (P/RC) = (P/RC) FC ACCYLIC: (OCC FT PANGES LCGIO(X/PC)	#ETEPS	CRATE TSHOT PFLL R/RC 31.9702 16.7798 6.3571 3.8720 3.1667 -3.514 CRATE TSHOT PELL R/RC	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1:49790 1:22479 -92206 -58794 -50060 COPPELATION C	24 MEYERS
DEVENS JAPRI PEELET DEPTH PIELO DATA! LST SQ FIT T DEVENS JAPRI PELLET DEPTH	L7415LB1SI OF BURIAN WFTEPS	DOB=0.2PTO L = 7.6 E SACT PFLU X/RC .3720 .4664 .5262 .5952 POVATION DOR=1.4PTP E SACT FFLU X/RC .2577	PANGE ACRYLICE FOM 11 RANGES LOGIO (X/PC) 5785% 35025 28330 22531 (P/RG) = FO ACCYLICE OCU 58887	., 3 INCH	CRATE TSHOT PFLL R/RC 31.4702 16.7798 6.3571 7.8720 3.1667 -3.514 CRATE TSHOT PELL R/RC 64.5954	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.02479 1.22479 .62206 .55794 .50060 COPPELATION C R PADJUS(RC)=1.1 FT RANGES LOG10(R/PC) 1.0100	24 METERS
DEVENS JAPRI PELLET DEPTM FIELD DATAF CEVENS JAPRI PELLET DEPTM FIELD DATAF	L74 SLB S OF BURIAN WETEPS	DOB= 0.2 PTO) L = 7.6 E SACT PFLU X/RC2976 .3720 .4464 .5262 .5952 ROUATION DOB= 0.4 PTO L = 4.7 E SACT FFLU X/RC .2277 .3222	FANGE ACRYLIC FCM 61 RAVES LOGIO(XFPC) 57678 42943 35025 26330 22531 (P/RC) = FC ACPYLIC: OCH FT OANGES LOGIO(XFPC) 58887 49192	., 3 INCH	CRATE TSHOT PELL R/RC 31.4702 16.7798 8.3571 3.8720 3.1667 -3.515 CRATE TSHOT PELL R/RC 64.5954 37.8505	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.42479 .02206 .58794 .50060 COMPELATION C R MADJUS(RC)=1.1 FT RANGES LOG10(R/PC) 1.71807	24 METERS
DEVENS JAPRI PELLET DEPTM FIELD DATAF CEVENS JAPRI PELLET DEPTM FIELD DATAF	L7415LB1SI OF BURTAI TO F BURTAI NOT STORT 1.057	DOB=0.2 PTO) L = 3.6 E SACT PFLLI X/RC .3720 .3720 .4664 .5282 .5952 ***GUATION DOR=0.4 PTO L = 4.3 E SACT FFLL X/RC .2*27 .3466	PANGF ACRYLIC FCM 11 RANGES LOGIO (X/PC) 52830 22931 (P/RG) = FC ACCYLIC: FC ACCYLIC:		CRATE R/RC T1.4702 16.7798 6.3571 7.8720 3.1667 -3.515 CRATE TSHOT PELL R/RC 64.5954 37.8505 73.85582	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.49790 1.22479 .7226 .55794 .50868 COPPELATION C R PADJUS(RC)=1.1 FT RANGES LOG10(R/PC) 1.71020 1.77307 1.37764	24 METERS
DEVENS JAPRI PELLET DEPTM FIELD DATAF CEVENS JAPRI PELLET DEPTM FIELD DATAF	L745LBtSI OF BURIAN WETEPS .381 .457 .533 .619 CUG-LOG LT45LBtS OF BURTA	DOB=0.2P10) L = 3.6 E SACT PFLLI X/RC .3720 .4664 .5262 .5952 ROWATION DOR=0.4P1P L = 4.3 E SACT FFLL X/RC .2=77 .7222 .3666 .4510	FANGE ACRYLIC FCM 11 RAGES LOGIO (XFPC) 57674 42943 35925 28330 22531 (P/RC) = MACPYLIC: 58883 49192 41274 41274 41274 41274		CRATE TSHOT PELL R/RC 31.4702 16.7798 8.3571 3.8720 3.1667 -3.515 CRATE TSHOT PELL R/RC 64.5954 37.8505	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.49790 1.22479 .7206 .55794 .50060 COMMELATION C R MADJUS(RC)=1.1 FT RANGES LOG10(R/PC) 1.7107 1.77764 .64861 .77996	OFFFICIENT= .9925
DEVENS JAPRI PELLET DEPTM FIELD DATAF CEVENS JAPRI PELLET DEPTM FIELD DATAF	L7415LB1SI OF BURIAN TO BURIAN WETEPS	DOB=0.2 PTO) L = 3.6 E SACT PFLLI X/RC .3720 .3720 .4664 .5282 .5952 ***GUATION DOR=0.4 PTO L = 4.3 E SACT FFLL X/RC .2*27 .3466	PANGE ACRYLIC FOM 11 RANGES LOGIO (X/PC) 57834 35025 22733 22733 (P/RC) = FO ACCYLIC: OCU FT DANGES LOGIO (X/PC) 5883 41274 34579 27565		CRATE TSHOT PFLL Q/RC 31.9702 16.7798 6.3571 1.8720 3.1667 -3.515 CRATE TSHOT PELL Q/RC 64.5954 37.8502 2.7088	R RADJUS(PC)*1.0 ET RANGES LOG10(R/PC) 1.49790 1.22479 .92206 .55794 .50860 COPPELATION C R MADJUS(RC)*1.1 FT RANGES LOG1018/PC) 1.F1020 1.F7807 3.37764 .48861 .57997	OFFFICIENT= .9925
DEVENS JAPRI PELLET DEPTH LST SQ FIT T DEVENS JAPRI PELLET DEPTH	L745LBtSI OF BURIAN WETEPS .381 .457 .533 .619 CUG-LOG LT45LBtS OF BURTA	DOB=0.2 PTO) = 3.6 E SACT PFLLI	FANGE ACRYLIC FCM 11 RAGES LOGIO (XFPC) 57674 42943 35925 28330 22531 (P/RC) = MACPYLIC: 58883 49192 41274 41274 41274 41274	., 3 INCH	CRATE TSHOT PFLL	R RADJUS(PC) = 1.0 ET RANGES LOG10(R/PC) 1.42479 .92206 .58794 .50060 COPPELATION C R PADJUS(RC) = 1.1 FT PANGES LOG10(R/PC) 1.71807 3.37764 .94816 .57967 .41836	OFFFICIENT= .9925
DEVENS JAPRI PELLET DEPTH LST SQ FIT T DEVENS JAPRI PELLET DEPTH	L7415LB1SI OF BURIAN WETEPS .381 .457 .533 .618 O LOG-LOG LT7415LB1S K OF BURIA	DOB=0.2P10) L = 3.6 E SHCT PFLU X/RC 3720.44664.5262.5952 ROWATTON DOR=0.4P10 X/RC 2577.3262.4510.4510.4510.4510.4510.4510.4510.4510	PANGF ACRYLIC FCM 11 RAYGES LOGIO (XFPC) 5785% 42943 35025 228330 22931 (P/RG) = MAGES LOGIO (XFPC) 58883 41974 41974 34579 23657 236579 23679 		CRATE TSHOT PFLL Q/RC 31.9702 16.7798 6.3571 1.8720 3.1667 -3.515 CRATE TSHOT PELL Q/RC 64.5954 37.8502 2.7088	R RADJUS(PC)=1.0 ET RANGES LOG10TR/PC) 1.22479 .82206 .55794 .50868 COPPELATION C R PADJUS(RC)=1.1 FT PANGES LOG10TR/PC) 1.71020 1.77807 1.37764 .68861 .47996 .8327	OFFFICIENT9925
DEVENS JAPRI PELLET DEPTM FIELD DATAS LST SQ FIT T DEVENS JAPRI PELLET DEPTM FIELD DATAS	L7415LB1SI OF BURIAN WETEPS .381 .457 .533 .619 O LOG-LOG LT7415LB1S OF BURIA	DOB=0.2P10) L = 3.6 E SACT PFLLI X/RC .3720 .4664 .5262 .5952 ROWATION DOR=0.4P1P L = 4.3 E SNCT FFLL X/RC .2=77 .7222 .3666 .4510 .4799 .6442 .7688 .7732	FANGE ACRYLIC FCM 1 RAVES LOGIO(XFPC) 57878 35025 28330 22531 (P/RC) = FC ACPYLIC: OCH FT DANGES LOGIO(XF) 149192 41274 34679 23665 19089 14570	R ROLE ROLE ROLE ROLE ROLE ROLE ROLE ROL	CRATE TSHOT PELL R/RC 31.4782 16.7798 6.3571 1.8720 3.1667 -3.515 CRAIF TSHOT PELL R/RC 64.5954 37.8505 27.8582 8.8680 3.8015 2.7008 1.4072 1.2113	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.42479 .22479 .22479 .58794 .58066 COPPELATION C R PAOTUS(RC)=1.1 FT RANGES LOG10(R/PC) 1.71020 1.77807 1.37764 .54861 .57996 .43277 .14836 .08327	OFFFICIENT* .5925
DEVENS JAPRI PETET DEPTH FIELD DATA! CEVENS JAPRI PETET DEPTH FIELD DATA: LST SQ FIT T	L7415LB1SI WHTTEPS .381 .457 .533 .618 O LOG-LOG LT7415LB1S O F RUNTA	DOB=0.2PION L = 3.6 E SACT PFLLI X/RC .3720 .4464 .5262 .5957 ROWATION DOR=0.4PIR L = 4.3 ESHCT FFLL X/RC .2=77 .7222 .3466 .7732 EDUATION	PANGF ACRYLIC FCM 11 RAYGES LOGIO (XFPC) 5785% 42943 35025 28130 22931 (P/RG) = FC ACPYLIC! FC OANGES LCGIO (XFPC) 41874 41974 34579 14950 14950 14950 14970 (R/PC) =		CRATE TSHOT PFLL Q/RC 31.4702 16.7798 6.3571 7.8720 3.1667 -3.514 CRATE TSHOT PELL R/RC 64.5954 37.8505 27.8582 8.8640 3.8015 2.7088 1.4072 1.2113	R RADJUS(PC)=1.0 ET RAMGES LOG10(R/PC) 1.09790 1.22479 .72206 .55794 .50060 COPPELATION C 1.71020 1.71020 1.71020 1.71020 1.7707 1.37776 .4361 .4327 .4836 .08327 CORRELATION C	OFFFICIENT= .9933
DEVENS JAPRI PETED DATA: LST SQ FIT T DEVENS JAPRI PETED DATA: LST SQ FIT T	L7415LB1S OF BURIAL WHTEPS 381 457 533 618 O LOG-LOG L7415LB1S 1 OF BURIAL	DOB=0.2PTON L = 7.6 E 7.6 E 7.6 E 7.6 3720 .3720 .3720 .3720 .5202 .5957 POWATION DOR=0.4PTON C=77 .222 .3866 .7732 EDUATION DOR=0.4017 L = 4.3	PANGF ACRYLIC FCM 11 RAYGES LOGIO (XYPC) 57859 28130 22931 (P/RG) = FC ACCYLIC! FC ACCYLIC! FC ACCYLIC! FC ACCYLIC! FC ACCYLIC! 58883 41274 34579 23665 11171 (R/RC) = VELLOM GLASS,		CRATE CRATE R/RC 31.9702 16.7798 8.3771 7.8720 3.1667 -3.514 CRATE ISHOT PELL R/RC 64.5954 37.8502 71.85582 8.8640 3.8015 7.7088 1.4072 1.2113 -3.821 CRATE	R RADJUS(PC)=1.0 ET RANGES LOG10TR/PC) 1.22479 .7226 .55794 .50868 COPPELATION C 1.21020 1.71020 1.71020 1.7107 1.37764 .64861 .57995 .4327 .08327 CORRELATION C	OFFFICIENT= .9933
DEVENS JAPRI PELLET DEPTH FIELD DATA! LST SQ FIT T DEVENS JAPRI PELLET DEPTH LST SQ FIT T	#FTEPS .305 .533 .619 .533 .619 .533 .619 .533 .619 .533 .619 .533 .636 .762 .338 .914 .60 LOG-LOG	DOB=0.2010 L = 3.6 ESACT PFLLI X/RC -3720 -4664 -5262 -526	PANGF ACRYLIC FCM 11 RAYGES LOGIO (XYPC) 57859 28130 22931 (P/RG) = FC ACCYLIC! FC ACCYLIC! FC ACCYLIC! FC ACCYLIC! FC ACCYLIC! 58883 41274 34579 23665 11171 (R/RC) = VELLOM GLASS,		CRATE TSHOT PFLL R/RC 31.9783 16.7798 6.3571 1.8720 3.1667 -3.514 CRATE TSHOT PFLL R/RC 64.5954 37.8505 27.8582 8.8840 3.8015 2.7088 1.4072 1.2113 -3.821 CRATE TSHOT PFLL	R RADJUS(PC)=1.0 ET RAMGES LOG10(R/PC) 1.09790 1.22479 .72206 .55794 .50060 COPPELATION C 1.71020 1.71020 1.71020 1.71020 1.7707 1.37776 .4361 .4327 .4836 .08327 CORRELATION C	OFFFICIENT* .9933 OEFFICIENT* .9933
DEVENS JAPRI PELLET DEPTH LST SQ FIT T DEVENS JAPRI PELLET DEPTH FIELD DATA: LST SQ FIT T QS-YENS JAPRI PELLET DEPTH PELLET DEPTH VICED DATA:	L7415LB1SI OF BURIAN WETEPS .381 .457 .533 .618 O LOG-LOG LT415LB1SI OF BURIAN WETERS .305 .457 .533 .686 .762 .838 .914 O LOG-LOG	DOB=0.2010 L = 3.6 ESACT PFLLI X/RO .3720 .4664 .5262 .5957 ROUATION DOR=0.4017 L = 4.3 ESACT FFLL X/RO .7732 EDUATION DOR=0.4017 L = 4.3 ESACT PFLL X/RO	PANGF ACRYLIC FEM FT RAYGES LOGIO (XFPC)		CRATE TSHOT PFLL Q/RC 31.4702 16.7798 6.3571 1.8720 3.1667 -3.514 CRATE TSHOT PFLL R/RC 64.5954 37.8502 2.8680 3.8019 2.7088 1.4072 1.2113 -3.821 CRATE TSHOT PFLL R/RC	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.49790 1.22479 .92206 .55794 .50860 COPPELATION C R MADJUS(RC)=1.1 FT RANGES LOG10(R/PC) 1.71020 1.77807 1.37764 .54861 .57997 .14636 .08327 CORRELATION C	OFFFICIENT= .9925 83 METERS OEFFICIENT= .9933
DEVENS JAPRI PETED DATA: LST SQ PIT T DEVENS JAPRI PETET DEPTH FIELD DATA: LST SQ FIT T Q: VENS JAPRI PETET DEPTH PIZZO DATA:	**************************************	DOB=0.2ntm L = 3.6 ESACT PFLLI X/RC -3720 -4664 -5282 -5952 ROWATION DOR=0.4ntp L = 4.3 ESHCT FFLL X/RC -227 -3866 -4732 EOUATION DOR=0.401Y L = 4.3 FSHOT PFLL X/RC -3666	PANGF ACRYLIC FOM 11 RAYGES LOGIO (X/PC) 5785% 28130 28130 28130 28130 28130 28130 28130 28130 41281 41274 34579 14150 14150 14150 14150 14174 14174 14174 14174 14174 14174 14174 14174 14174 14174 14174 14174 14174		CRATE TSHOT PFLL R/RC 31.4702 16.7798 6.3791 3.1667 -3.514 CRATE TSHOT PFLL R/RC 64.5954 37.8505 27.8505 27.8505 27.8505 27.8501 27.088 1.4072 1.2113 -3.821 CRATE TSHOT PFLL R/RC 31.2036	R RADJUS(PC)=1.0 ET RAMGES LOG10(R/PC) 1.29790 1.22479 .72296 .55794 .5080 COPPELATION C 1.21020 1.22020 1.2202	OFFFICIENT= .9925 63 METERS OEFFICIENT= .9933
DEVENS JAPRI PELLET DEPTH LST SQ FIT T DEVENS JAPRI PELLET DEPTH FIELD DATA: LST SQ FIT T QS-YENS JAPRI PELLET DEPTH PELLET DEPTH VICED DATA:	L7415LB1S 107 8URIA WETEPS 381 457 533 618 10 L0G-L0G L7415LB1S 457 533 686 762 838 914 10 L0G-L0G L7415LB1S 10 L0G-L0G L7415LB1S 10 L0G-L0G L7415LB1S 10 L0G-L0G	DOB=0.2PTON L = 7.6 E 7.6 E 7.6 E 7.6 3720 .3464 .5262 .5952 POWATION DOR=0.4017 L = 4.7 ESHCT FFLL X/PC .227 .3666 .7732 EDUATION DOR=0.4017 L = 4.3 FSHOT PFLL X/PC .3666 .4510	PANGF ACRYLIC FCM F1 RAYGES LOGIO (XXPC) 57854 42943 35025 F1 ACCYLIC: F1 ACCYLIC: F1 PANGFS LCGIO (XXPC) 5883 49192 41274 34579 11371 (R/QC) = F1 RAYGES LOGIO (XXPC) 14950 11171 14970 14274 14970 -		CRATE TSHOT PFLL R/RC 31.4702 16.7798 8.3711 7.8720 3.1667 -3.514 CRATE TSHOT PFLL R/RC 64.5954 37.8505 73.8582 8.6640 3.6015 77.088 1.4072 1.2113 -3.821 CRATE TSHOT PFLL R/RC 31.2036 19.5784	R RADJUS(PC)=1.0 ET RANGES LOG10(R/PC) 1.49790 1.22479 .5276 .58794 .50868 COPPELATION C 1.71020 1.77807 1.37764 .54861 .57996 .4327 CORRELATION C R RADJUS(RC)=1.1 ET RANGES LOG10(R/PC) 1.61020 1.7807 1.37764 .54861 .57996 .4327 CORRELATION C	OFFFICIENT= .9925 83 METERS OEFFICIENT= .9933
DEVENS JAPRI PETED DATA: LST SQ PIT T DEVENS JAPRI PETET DEPTH FIELD DATA: LST SQ FIT T Q: VENS JAPRI PETET DEPTH PIZZO DATA:	L7415LB1SI OF BURIAN OF BURIAN NETEPS	DOB=0.2nt() = 3.6 ESACT PFLL X/RC	FANGE ACRYLIC FEM FIT RATES LOGIO (XFPC)	2 TACH	CRATE TSHOT PFLL R/RC 31.9702 316.7798 6.3571 1.8720 3.1667 -3.515 CRATE TSHOT PFLL R/RC 64.5954 37.8505 27.8505 27.8505 2.7088 1.4072 1.2113 -3.821 CRATE TSHOT PFLL R/RC 31.82036 1.9784	R RADJUS(PC)=1.0 ET RAMGES LOG10(R/PC) 1.29790 1.22479 -22206 -58794 -50060 COPPELATION C 1.71020 1.7164 -64861 -5796 -43277 CORRELATION C R RADJUS(RC)=1.1 ET RAMGES LOG10(R/PC) 1.71020 1.7164 -64861 -5796 -4327 CORRELATION C R RADJUS(RC)=1.1 ET RAMGES LOG10(R/RC) 1.49820 1.29367 -88814	OFFFICIENT= .9925 83 METERS OEFFICIENT= .9933
DEVENS JAPRI PETED DATA: LST SQ PIT T DEVENS JAPRI PETET DEPTH FIELD DATA: LST SQ FIT T Q: VENS JAPRI PETET DEPTH PETET DEPTH PETET DEPTH PETET DEPTH	### C LOG	DOB=0.2PTON L = 7.6 E 7.6 E 7.6 E 7.7 .3720 .4464 .5282 .5952 ***GUATION ***COMMON TON ***COMMON T	PANGF ACRYLIC FCM 11 RAVGES		CRATE TSHOT PFLL R/RC 31.4702 16.7798 8.3711 7.8720 3.1667 -3.514 CRATE TSHOT PFLL R/RC 64.5954 37.8505 77.85582 8.6640 3.6015 77.088 1.4072 1.2113 -3.821 CRATE TSHOT PFLL R/RC 31.2036 19.5784 7.7298	R RADJUS(PC)=1.0 ET RANGES LOG10TR/PC) 1.22479 .7226 .55794 .50868 COPPELATION C 1.21020 1.71020 1.71020 1.7107 1.37764 .50861 .50327 CORRELATION C R RADJUS(RC)=1.1 ET RANGES LOG10TR/PC) 1.0510TR/PC) 1.0510TR/PC	OFFFICIENT= .9925 83 METERS OEFFICIENT= .9933
DEVENS JAPRI PETED DATA: LST SQ PIT T DEVENS JAPRI PETET DEPTH FIELD DATA: LST SQ FIT T Q: VENS JAPRI PETET DEPTH PETET DEPTH PETET DEPTH PETET DEPTH	L7415LB1SI OF BURIAN OF BURIAN NETEPS	DOB=0.2nt() = 3.6 ESACT PFLL X/RC	FANGE ACRYLIC FEM FIT RATES LOGIO (XFPC)	2 TACH	CRATE TSHOT PFLL R/RC 31.4702 16.7798 6.3571 7.8720 3.1667 -3.514 CRATE TSHOT PFLL R/RC 64.5954 37.8502 5.8040 3.8015 7.7088 1.4072 1.2113 CRATE TSHOT PFLL R/RC 31.2036 1.4072 1.213 TSHOT PFLL R/RC 31.2036 31.2036 31.2036 31.2036 31.2036	R RADJUS(PC)=1.0 ET RAMGES LOG10(R/PC) 1.29790 1.22479 -22206 -58794 -50060 COPPELATION C 1.71020 1.7164 -64861 -5796 -43277 CORRELATION C R RADJUS(RC)=1.1 ET RAMGES LOG10(R/PC) 1.71020 1.7164 -64861 -5796 -4327 CORRELATION C R RADJUS(RC)=1.1 ET RAMGES LOG10(R/RC) 1.49820 1.29367 -88814	OFFFICIENT= .9925 83 METERS OEFFICIENT= .9933

Table A2. Preshot and Postshot Distances of Individual Tellcis (Cont)

				POST			
PZELO DATAI		X/ WC	COGIOTX/RC		RIRC	LOGI STRINGT	
	HETERS			METERS			
	* 45 F	.3866	41274	29.358	24.8247	1.39488	
	•533	.4510	-,34579	9.431	7.9742	.90169	
	.618	.5155	287#0	4.365	3,6907	.56711	
	.686	.5799	23665	3.652	3,0876	.48963	

ST SQ FIY T	0.106-106	FORATION	{R/RC}=	.140* (X/RC)**	-E 270	CORRELATION COEFFICIENT	- 0744
		C40-110N				CORRECAL TON COCKLICITUM	- 43/10
DEVENC TRADE	T: 74151 91	S000-0.502	VELLOW CLA	55, 2 INCH	COATO	R RADIUS (RC) = 1.280 HFTERS	
PELLET DEPTH				714 K 1404	ONFIE	* KPD103(FC)-11200 III 1ERS	
, , , , , , , , , , , , , , , , , , , ,			T RANGES	POST	SHOT DELL	ET PANGES	
TELO DATAT	¥	X/RC	L0610 (X/PC			LOGIO(P/RC)	
TEED OWIN.	HETERS	-/"	CHOTO (X) LO	. 4ETERS	K/10	CHOID(W/WC)	
	.457	. 3571	-,44716	35.585	27.7976	1.44401	
	.610	.4762	32222	16.307	12.7381	1.10510	
	.688	:5357	77107	9,943	7.0643	.84907	
	.762	.5952	22531	6.757	5.2786	.72252	
	.636	.4548	18392	4.039	3.1548	. 49897	
	.914	.7143	14613	1.024	2.3619		
ST SQ FIT T	O FOC-FOC	COUATION	(R/QC) =	.737*(X/RC) **	-3.626	CORRELATION COEFFICIENT	= .993
EVENS GLUNF	74:51 R. <	008=8.501	FF9 ACRYLIC	. 2 THCH	CDATE	P RADIUS(PC) ±1.259 METERS	
ELLET DEPTH					48417		
			FT RANGES		SHOT PELL	ET PANGES	
TELO DATAL	×		LOGIS (X/RC			LOG1E(R/RC) - "	
FEFO GRIME		A/ NU	CIPITA CXARC		KAKE	COGICER/RGJ	
	HETERS			HETERS			
	. 385	.2421	61595		18.4915	1.76697	
	.381	.3027	51984	17.331	13.7676	1.13886	
	.457	.3632	43986	12,503	9.9322	.99705	
	•533	.4237	37291	11.421	9,0726	. 95773	
	618.	. 4843	31492	19.257	A.1477	. 51184	
	.686	.5448	26377				
				8.632	6.8571	.83614	
•	.762	.6053	21801	4.093	3.2518	•51713	
	. 838	.6659	17662	2,774	2.2034	.34309	
•	-914	.72f4	13883	1.774	1.4092	.14897	
				7 4 4 4 4			

37 30 PIT P	0 1.06-106						z 93m
:37 30 PIT P	' 0 '1.06 *1 0 6			1 • 12 4 + (X/BC) + •		COPRELATION COEFFICIENT	=,9301
:37 30 P17 P	' 0 'L 0G-LOG						±9301
		FOUAT 104	(R/RC) ±	1+134*(X/RC)*+	-2.164	COPRFLATION COEFFICIENT	± 9301
DEVENS 6JUNE	7415LB, S	EQUATION DOB=0.501 L = 5.8	(R/RC)± PLUF GLASS, 8CM	S INCH	-2.164		* , 9301
NEVENS 6JUNE	7415LB, S	EQUATION DOB=0.501 L = 5.8	(R/RC)± PLUF GLASS, 8CM	\$ INCH	-2.164 CRATE	COPRFLATION COEFFICIENT R RADIUS(PC)=1.259 MFTERS	٠
NEVENS 6JUNE PELLET DEPTH	7415LB, S	EQUATION DOB=0.501 L = 5.8 FSHOT-PFLL	(R/RC)± PLUF SLASS, 6CH FT RANGES++	2 INCH POST	-2.164 CRATE SHOT PELL	COPRFLATION COEFFICIENT R RADIUS(RC)=1.259 HFTERS ET RANGES-UL-	٠
NEVENS 6JUNE PELLET DEPTH	7415LB; Si of Burial	EQUATION DOB=0.501 L = 5.8 FSHOT-PFLL	(R/RC)± PLUF GLASS, 8CM	2 INCH POST	-2.164 CRATE SHOT PELL	COPRFLATION COEFFICIENT R RADIUS(PC)=1.259 MFTERS	٠
NEWENS 6JUNE PELLET DEPTH	7415LB, SI OF BURIAL X METERS	EQUATION DOB=0.501 L = 5.8 PSHOT-PFLL X/90	(R/RC) # PLUE SLASS, 6CM FT RANGES++ LOG10(X/PC	2 INCH 2 INCH POST 1 R	-2.164 CRATE SHOT PELL R/RC	COPRFLATION COEFFICIENT R RADIUS(PC) =1.259 HFTERS ET RANGES-Ja	٠
NEWENS 6JUNE PELLET DEPTH	7415LB, SI OF BURIAL X METERS .305	EQUATION DOB=0.501 L = 5.8: F\$HOT: PFLL: X/90 .2421	(R/RG) = PLUF SLASS, 6CM FT RANGES++ LOGID(X/PC	1.134*(*/RC)** 2 INCH	-2.164 CPATF SHOT PELL R/RC 13.5472	COPRFLATION COEFFICIENT R RADIUS(RC)=1.259 MFTERS ET RANGES-UN	٠
NEWENS 6JUNE PELLET DEPTH	7415LB, SI OF BURIAL X METERS .305 .381	EQUATION DOB=0.501 L = 5.8: F\$HOT-PFLU X/90 .2421 .3627	(R/RC) = PLUF SLASS, 6CM FT RANGES++ LOG10(X/PC51595	2 INGH 	-2.164 CRATE SHOT PELL R/RC 13.5472 10.5738	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.259 MFTERS ET RAMGFS====================================	٠
NEWENS 6JUNE PELLET DEPTH	74 518, Si OF BURIAL X METERS .305 .381 .457	000 = 0.50 t 0.00 0	(R/RG) ± PLUF SLASS, 6 CM FT RANGES+ LOG10 (X/PC5190441966	2 INCH 2 INCH 	-2.164 CRATE SHOT PELL R/RC 13.5972 10.5738 8.2082	COPRFLATION COEFFICIENT R RADIUS(RC) =1.259 NFTERS ET RANGES-44	٠
NEVENS 6JUNE PELLET DEPTH	7415LB, SI OF BURIAL X METERS .305 .381	008=0.501 L = 5.0: PSHOT PFLLY X/RC .2421 .3027 .3632 .4237	(R/RC) ± PLUF SLASS, 6 CM FT PANGES LOG10 (X/PC51595519044798637291	2 INGH 	-2.164 CRATE SHOT PELL R/RC 13.5972 10.5738 8.2082	COPRFLATION COEFFICIENT R RADIUS(RC) =1.259 NFTERS ET RANGES-44	٠
NEVENS 6JUNE PELLET DEPTH	74 518, Si OF BURIAL X METERS .305 .381 .457	008=0.501 L = 5.0: PSHOT PFLLY X/RC .2421 .3027 .3632 .4237	(R/RC) ± PLUF SLASS, 6 CM FT PANGES LOG10 (X/PC51595519044798637291	2 INCH 2 INCH 	-2.164 CRATF SHOT PELL R/RC 13.5472 10.5738 8.2082 6.1797	COPRFLATION COEFFICIENT R RADIUS(PC) = 1.259 MFTERS ET RAMGF5 LOG10 (P-PC) 1.13185 1.02423 .91425 .79093	٠
NEVENS 6JUNE PELLET DEPTH	7415LB, SI OF BURIAL X METERS .305 .381 .457 .933 .610	DOB=0.501 L = 5.0 PSHOT PFEL X/9 .2421 .3827 .3632 .4833 .4843	(R/RC) ± PLUF GLASS, 6CM TO RANGES LOG10(X/PC51595519044398631997	2 INCH 2 INCH 	-2.164 CPATF SHOT PFLL R/RC 13.5472 10.5738 8.2082 6.1792 4.0557	COPRFLATION COEFFICIENT R RADIUS(PC) =1.259 HFTERS ET RANGES-UL- LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .6'806	٠
ST 30 PIT T SEVENS GJUNE FELLET DEPTH FIELD DATA!	7415LB; SI OF BURIAL METERS .305 .381 .457 .733 .610 .686	DOB=0.501 / L = C.n. PFLU X/QC . 2421 . 3632 . 4237 . 4643 . 5448	(R/RC) ± PLUF SLASS, 6CH FT RANGES LOG10(X/PC515955159643986372913149725177	2 INCH 2 INCH 	-2.164 CRATF SHOT PFLL R/RC 13.5472 10.5738 8.2082 6.1792 4.0557 2.4964	COPRFLATION COEFFICIENT R RADIUS(PC)=1.259 MFTERS ET RANGES-UR- LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .6'806 .79731	
NEVENS 6JUNE PELLET DEPTH	74 \$5LB, SI OF BURIAL X MFTERS .305 .381 .457 .753 .610 .686 .752	DOB=0.501 L = 5.01 K = 5.01 X/RC .2421 .3627 .3632 .4237 .4643 .5648 .6053	(R/RC)± PLUF GLASS, 50M FT RANGES LOG10(X/PC5159551904	2 INCH 2 INCH 2 INCH 3 MEIERS 17,054 13,311 10,331 7,778 5,105 1,142 2,042	-2.164 CRATE SHOT PELL R/RC 13.5472 10.5738 8.2082 8.1792 4.0557 2.4964 1.6223	COPRFLATION COEFFICIENT R RADIUS(PC) =1.259 MFTERS ET RAMGFS==1==	٠
NEVENS 6JUNE PELLET DEPTH	7415LB, Si OF BURIAL X METERS .305 .381 .457 .933 .610 .686 .762 .838	DOB=0.501 (= 5300 PFLU X/RC -2421 -3632 -4237 -4643 -5448 -6659	(R/RC)± PLUF GLASS, 6CM PT PANGES LOGIO(X/PC51595519044398631492764772180117662	2 INCH 2 INCH 3 MEIERS 17.054 13.311 10.333 7.778 5.105 3.142 2.042 1.512	-2.164 CRATE SHOT PELL R/RC 13.5472 10.5738 8.2082 8.1792 4.0557 2.4964 1.6223 1.2010	COPRFLATION COEFFICIENT R RADIUS(PC)=1.259 MFTERS ET RANGES-UR- LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .6'806 .79731	٠
NEWENS 6JUNE PELLET DEPTH	74 \$5LB, SI OF BURIAL X MFTERS .305 .381 .457 .753 .610 .686 .752	DOB=0.501 L = 5.01 K = 5.01 X/RC .2421 .3627 .3632 .4237 .4643 .5648 .6053	(R/RC)± PLUF GLASS, 50M FT RANGES LOG10(X/PC5159551904	2 INCH 2 INCH 2 INCH 3 MEIERS 17,054 13,311 10,331 7,778 5,105 1,142 2,042	-2.164 CRATE SHOT PELL R/RC 13.5472 10.5738 8.2082 8.1792 4.0557 2.4964 1.6223	COPRFLATION COEFFICIENT R RADIUS(PC) =1.259 MFTERS ET RAMGFS==1==	٠
EVENS 6JUNE ELLET DEPTH TELD DATAI	7415LB, SI OF BURIAL X METERS .305 .381 .457 .610 .686 .752 .610 .686 .752	EQUATION DOB=0.501 / L =	(R/RC)± PLUF GLASS, 6CM FY PANGES LOGIO(X/PC51595519044798631997218011766213883	2 INCH 2 INCH	-2.164 CRATF SHOT PELL R/RC 13.5472 10.5738 8.2082 6.2082 6.0557 2.4964 1.6223 1.2010 1.0291	COPRFLATION COEFFICIENT R RADIUS(RC) =1.259 MFTERS ET RANGES-UL- LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .6'806 .79731 .21912 .07353 .01244	
EVENS 6JUNE ELLET DEPTH TELO DATAI	7415LB, SI OF BURIAL X METERS .305 .381 .457 .610 .686 .752 .610 .686 .752	EQUATION DOB=0.501 / L =	(R/RC)± PLUF GLASS, 6CM FY PANGES LOGIO(X/PC51595519044798631997218011766213883	2 INCH 2 INCH 3 MEIERS 17.054 13.311 10.333 7.778 5.105 3.142 2.042 1.512	-2.164 CRATF SHOT PELL R/RC 13.5472 10.5738 8.2082 6.2082 6.0557 2.4964 1.6223 1.2010 1.0291	COPRFLATION COEFFICIENT R RADIUS(RC) =1.259 MFTERS ET RANGES LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .6'806 .79731 .21912 .27153 .01244	
NEVENS 6JUNE VELLET DEPTH FIELD DATAI	74 SLB , SI OF BURIAL X X MFTERS 305 457 457 610 686 762 616	EQUATION DOB=0.501 L = 5.0: PSHOT PPLU X/90 -2421 -3632 -4237 -4643 -5448 -6053 -6659 -7264 FOUATION	(R/RC)± PLUF GLASS, 5CM FT RANGES LOG10(X/PC515955190443926172913149226177214011766213883 (R/PC)=	2 INCH 2 INCH RETERS 17,054 13,311 10,333 7,778 5,105 3,142 2,042 1,512 1,295	-2.164 CRATF SHOT PFLL R/RC 13.5473 8.2082 6.1792 4.0557 2.4964 1.6223 1.2010 1.0291 -2.534	COPRFLATION COEFFICIENT R RADIUS(RC) =1.259 MFTERS ET RANGES-UL- LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .6'806 .79731 .21912 .07353 .01244	
EVENS 6.JUNE ELLET DEPTH ZELD DATA1 ST SQ FIT T	74 SLB, SI OF BURIAL STEEL S	EQUATION DOB=0.501 L = 5.0. PSHOT PFLU X/RC -2421 -3632 -4237 -4683 -5448 -6053 -6659 -7264 FOUATION	(R/RC)± PLUF GLASS, 6CM FY PANGES LOGIO(X/PC5159551904479863199721801 -1766213883 (R/PC)=	2 INCH 2 INCH	-2.164 CRATF SHOT PFLL R/RC 13.5472 10.5738 8.2082 5.1792 4.0557 2.49623 1.2010 1.0291 -2.534	COPRFLATION COEFFICIENT R RADIUS(RC) =1.259 MFTERS ET RANGES-UL- LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .6'806 .79731 .21912 .07353 .01244	
EVENS 6.JUNE ELLET DEPTH LELD DATA1	74 SLB, SI OF BURIAL X X MFTERS 305 381 457 457 610 686 752 616 616 752 616 616 752 616 616 752 616	DOB=0.501 L = 5.0: C = 5.0:	(R/RC) ± PLUF GLASS, 6CM FT RANGES LOG10(X/PC,51595,51904,43986,37291,31492,76477,21801,17662,13883 (R/PC) =	2 INCH 2 INCH Refreq 17,054 13,311 10,331 7,778 5,105 1,142 2,042 1,512 1,512 1,512 1,515 1,517 1,51	-2.164 CRATF SHOT PFLL R/RC 13.55/78 8.2082 6.1792 4.0557 2.4964 1.6223 1.2010 1.2010 1.2034	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.759 MFTERS ET RAMGFS-Ja LOG10 (P/PC) 1.13185 1.02423 .91425 .79033 .67806 .79731 .2112 .C77153 .01244 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS	
NEVENS GJUNE FIELD DATAI LST SO FIT T HEVENS GJUNE FILLET DEPTH	74:5LB, SI OF BURIAL X MFTERS .305 .381 .457 .933 .610 .686 .752 .838 .914 .C LOG-LOG	DOB=0.501 L = 5.0. PSNOT PFLL X/RC .2421 .3632 .4237 .4683 .5488 .6053 .6659 .7264 FOUATION SDOR=0.201 L = 5.01	(R/RC) ± PLUF GLASS, 6CM FT PANGES LOGIO (X/PC5159551904439863729131997218011768213883 (Q/PC)= RPOWN GLASE PCH	2 INCH 2 INCH	-2.164 CRATF SMOT PFLL R/RC 13.5737 8.2082 6.1797 2.4964 1.6223 1.2010 1.0291 -2.534	COPRFLATION COEFFICIENT R RADIUS(RC)=1.259 HFTERS ET RANGES LOGIO (P/RC) 1.13185 1.02423 .91425 .79093 .6'806 .79731 .21112 .07153 .01244 CORRELATION COEFFICIENT R RADIUS(RC)=1.000 METERS ET PANGES	
NEWENS GJUNE TELO DATAI ST SO FIT T TEVENS GJUNE TEVENS GJUNE	74 5 LB , SI OF BURIAL X X X	DOB=0.501 L = 5.0. PSNOT PFLL X/RC .2421 .3632 .4237 .4683 .5488 .6053 .6659 .7264 FOUATION SDOR=0.201 L = 5.01	(R/RC) ± PLUF GLASS, 6CM FT RANGES LOG10(X/PC,51595,51904,43986,37291,31492,76477,21801,17662,13883 (R/PC) =	2 INCH 2 INCH	-2.164 CRATF SMOT PFLL R/RC 13.5737 8.2082 6.1797 2.4964 1.6223 1.2010 1.0291 -2.534	COPRFLATION COEFFICIENT R RADIUS(RC)=1.259 HFTERS ET RANGES LOGIO (P/RC) 1.13185 1.02423 .91425 .79093 .6'806 .79731 .21112 .07153 .01244 CORRELATION COEFFICIENT R RADIUS(RC)=1.000 METERS ET PANGES	
EVENS 6.JUNE ELLET DEPTH LELD DATA1	74:5LB, SI OF BURIAL X MFTERS .305 .381 .457 .933 .610 .686 .762 .616 .914 .C LOG-LOG	DOB=0.501 L = 5.0. PSNOT PFLL X/RC .2421 .3632 .4237 .4683 .5488 .6053 .6659 .7264 FOUATION SDOR=0.201 L = 5.01	(R/RC) ± PLUF GLASS, 6CM FT PANGES LOGIO (X/PC5159551904439863729131997218011768213883 (Q/PC)= RPOWN GLASE PCH	2 INCH 2 INCH	-2.164 CRATF SMOT PFLL R/RC 13.5737 8.2082 6.1797 2.4964 1.6223 1.2010 1.0291 -2.534	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.759 MFTERS ET RAMGFS-Ja LOG10 (P/PC) 1.13185 1.02423 .91425 .79033 .67806 .79731 .2112 .C77153 .01244 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS	
NEWENS GJUNE TELO DATAI ST SO FIT T TEVENS GJUNE TEVENS GJUNE	74:5LB, SI OF BURIAL X MFTERS .305 .381 .457 .933 .610 .686 .762 .616 .914 .C LOG-LOG	EQUATION DOB=0.501 L = 5.0: PSHOT PPLU: X/90 .2421 .3632 .4237 .4843 .5448 .6053 .6659 .7264 FOUATTON SOOR=0.201 L = 5.0: SHOT FPLU: X/80	(R/RC) ± PLUF GLASS, 5CM FT RANGES LOG10(X/PC	2 INCH 2 INCH R 17.054 13.311 10.333 7.778 5.105 3.149 2.042 1.512 1.295 .51F*(X/RC)**	-2.164 CRATF PTLL R/RC 13.5472 8.2082 6.1792 4.0557 2.4964 1.6223 1.2010 1.0291 -2.534 CRATE SHOT LL	COPRFLATION COEFFICIENT R RADIUS(RC) =1.259 MFTERS ET RAMGES LOGIO (P/PC) 1.13245 1.0245 .7903 .6'806 .79731 .2112 .07153 .01244 CORRELATION COEFFICIENT R RADIUS(RC) =1.000 METERS FT RANGES LOGIO(R/PC)	
NEWENS GJUNE TELO DATAI ST SO FIT T TEVENS GJUNE TEVENS GJUNE	74;5LB, SI OF BURIAL X MFTERS .305 .381 .457 .933 .610 .686 .752 .914 .C LOG-LOG .GF BUPIAL	EQUATION DOB=0.501 L = 5.0: PSHOT PFLU X/R .3027 .3632 .4237 .4643 .5446 .6053 .6059 .7264 FOUATION SOOR=0.201 L = 5.0: SHCT FFLU X/RC .3611	(R/RC)± PLUF GLASS, 6CM FY PANGES LOGIO(X/PC51595519043199776177218011766213883 (R/PC)= RROWN GLAS PCH LT PANGES LOGIO(X/PC	2 INCH 2 INCH	-2.164 CRATE SHOT PELL R/RC 13.5472 10.5738 8.2082 6.1797 2.4964 1.6223 1.2010 1.0291 -2.534 CRATE SHOT LL 9/RC 31.6494	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.259 METERS ET RANGES LOG10 (P/PC) 1.13185 1.02423 .91425 .79093 .67806 .79731 .21912 .07:753 .01244 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS FT RANGES LOG10(R/PC) 1.50037	
NEVENS GJUNE TELD DATAI ST SO FIT T TEVENS GJUNE TEVENS GJUNE TEVENS GJUNE	74:518, SI OF BURIAL X MFTERS .305 .381 .457 .933 .610 .686 .762 .914 .C LOG-LOG .74: SLB,	DOB=0.501 (L = 5.0) (PSHOT PPLL) (X/90 3632 3632 4843 4843 4843 4845	(R/RC) ± PLUF GLASS, 6CH FT PANGES LOG10 (X/PC51595519044798637497218011766213883 (R/PC) = RPOWN GLAS PCH T PANGES LOG10 (X/PC41896	2 INCH 2 INCH R MEIERS 17,054 13,351 10,333 7,778 5,105 3,142 2,042 1,512 1,512 1,525 .51F*(X/RC)**	-2.164 CRATF SHOT PFLL R/RC 13.5472 10.5778 8.2082 6.1792 4.0557 2.4964 1.6223 1.2010 1.0293 1.2010 1.0293 1.2010 1.0293 1.2010 1.0293 1.2010 1.0293 1.2010 1.0293 1.2010 1.0293 1.2010 1.0293 1.2010 1.0293	COPRFLATION COEFFICIENT R RADIUS (RC) = 1.259 MFTERS ET RAMGFT====================================	
NEVENS GJUNE TELD DATAI ST SO FIT T TEVENS GJUNE TEVENS GJUNE TEVENS GJUNE	74:5LB, SI OF BURIAL X METERS .305 .381 .457 .610 .686 .752 .838 .914 .C LOG-LOG	DOB=0.501 L = S.N. PSHOT PFLU X/RC . 3632 .3632 .3632 .3632 .5448 .6053 .6659 .7264 FOUATION SDOR=0.201 L = S.N. SHOT FFLU X/RC . 3611 .4573 .5315	(R/RC)± PLUF GLASS, 6CM FT PANGES LOG10 (X/PC515955190443986372911768213683 (Q/PC)= RROWN GLAS PCH	2 INCH 2 INCH	-2.164 CRATF SMOT PFLL R/RC 13.5478 8.2082 6.1797 2.4964 1.6223 1.2010 1.0291 -2.534 CRATE SMOT LL 9/RC 31.6494 13.6533 4.2813	COPRFLATION COEFFICIENT R RADIUS(RC) =1.259 HFTERS ET RANGES LOGIO (P/RC) 1.13185 1.02423 .91425 .79093 .6'086 .79731 .21312 .07353 .01244 CORRELATION COEFFICIENT R RADIUS(RC) =1.000 METERS FT PANGES LOGIO(R/PC) 1.50037 1.13492 .63180	
NEVENS GJUNE TELD DATAI ST SO FIT T TEVENS GJUNE TEVENS GJUNE TEVENS GJUNE	74 SLB, SI OF BURIAL X MFTERS	DOB=0.501 (L = 5.0) (PSHOT PFLU X/90 .3827 .3632 .4237 .4643 .5448 .6659	(R/RC) ± PLUF GLASS, 6CH FT RANGES51994 -41986 -37291 -31499 -26477 -213883 (R/PC) = RPOWN GLAS PCH -1 T PANGES LOG10 (X/PC) -41896 -33978 -27784 -27784	2 INCH 2 INCH R HEIFOR 17,054 13,311 10,331 7,778 5,105 1,142 2,042 1,512 1,512 1,512 1,517 1,642 1,1640 4,287 3,191	-2.164 CRATF SHOT PFLL 13.547? 10.5736 8.2082 6.2057 4.0557 2.4964 1.6223 1.2010 1.0291 -2.534 CRATE CRATE 31.8494 13.6433 4.2835 3.1921	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.759 MFTERS ET RAMGFS LOG10 (P/PC) 1.13185 1.02423 .91425 .79093 .67806 .79731 .2112 .C7153 .01244 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS FT PANGES LOG10(R/PC) 1.5037 1.13492 .63180 .50407	
NEVENS GJUNE TELD DATAI ST SO FIT T TEVENS GJUNE TEVENS GJUNE TEVENS GJUNE	74:5LB, SI OF BURIAL X METERS .305 .381 .457 .610 .686 .752 .838 .914 .C LOG-LOG	DOB=0.501 L = S.N. PSHOT PFLU X/RC . 3632 .3632 .3632 .3632 .5448 .6053 .6659 .7264 FOUATION SDOR=0.201 L = S.N. SHOT FFLU X/RC . 3611 .4573 .5315	(R/RC)± PLUF GLASS, 6CM FT PANGES LOG10 (X/PC515955190443986372911768213683 (Q/PC)= RROWN GLAS PCH	2 INCH 2 INCH	-2.164 CRATF SMOT PFLL R/RC 13.5478 8.2082 6.1797 2.4964 1.6223 1.2010 1.0291 -2.534 CRATE SMOT LL 9/RC 31.6494 13.6533 4.2813	COPRFLATION COEFFICIENT R RADIUS(RC) =1.259 HFTERS ET RANGES LOGIO (P/RC) 1.13185 1.02423 .91425 .79093 .6'086 .79731 .21312 .07353 .01244 CORRELATION COEFFICIENT R RADIUS(RC) =1.000 METERS FT PANGES LOGIO(R/PC) 1.50037 1.13492 .63180	
EVENS GJUNE ELLET DEPTH SELD DATA! SY SO FIT T EVENS GJUNE ELLET DEPTH TELD DATAR	74 SLB SI SI SI SI SI SI SI S	EQUATION DOB=0.501 L = 5.0. FSHOT **PILU* X/RC* .3827 .3632 .4237 .4843 .4843 .4843 .4843 .5448 .6053 .6059 .7264 FOUATTON SDOR=0.201 L = 5.0 X/RC* .3811 .4573 .5038 .6038 .6038 .6060	(R/RC) ¥ PLUF GLASS, 6CH FT RANGES L0G10(X/PC515955190443986176610 RPOWN GLAS PCH17686S L0G10(X/PC418963397A2728416349	2 INCH 2 INCH R HELEGS 17,054 13,311 10,331 7,778 5,105 1,142 2,042 1,512 1,525 .51F*(X/RC)**	-2.164 CRATE CRATE 13.5472 10.5736 8.2082 6.2057 1.2010 1.0291 -2.534 CRATE CRATE CRATE 1.0201 1.029	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.259 METERS ET RAMGFS LOG10 (P/PC) 1.13185 1.02423 .91425 .79093 .67806 .79731 .2112 .27153 .01744 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS FT RAMGES LOG10(R/PC) 1.50037 1.13492 .63180 .50407 .12758	
EVENS GJUNE ELLET DEPTH SELD DATA: ST SQ FIT T EVENS GJUNE ELLET DEPTH IELD DATA:	74 SLB SI SI SI SI SI SI SI S	EQUATION DOB=0.501 L = 5.0. FSHOT **PILU* X/RC* .3827 .3632 .4237 .4843 .4843 .4843 .4843 .5448 .6053 .6059 .7264 FOUATTON SDOR=0.201 L = 5.0 X/RC* .3811 .4573 .5038 .6038 .6038 .6060	(R/RC) ¥ PLUF GLASS, 6CH FT RANGES L0G10(X/PC515955190443986176610 RPOWN GLAS PCH17686S L0G10(X/PC418963397A2728416349	2 INCH 2 INCH R HEIFOR 17,054 13,311 10,331 7,778 5,105 1,142 2,042 1,512 1,512 1,512 1,517 1,642 1,1640 4,287 3,191	-2.164 CRATE CRATE 13.5472 10.5736 8.2082 6.2057 1.2010 1.0291 -2.534 CRATE CRATE CRATE 1.0201 1.029	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.759 MFTERS ET RAMGFS LOG10 (P/PC) 1.13185 1.02423 .91425 .79093 .67806 .79731 .2112 .C7153 .01244 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS FT PANGES LOG10(R/PC) 1.5037 1.13492 .63180 .50407	* • 9757
ST SO FIT T	74:518, SI OF BURIAL X MFTERS .305 .381 .457 .933 .610 .686 .762 .630 .914 .C LOG-LOG .74: SLB, SI GF BUPIAL X MFTERS .301 .457 .532 .610 .686 .0 LOG-LOG	COUNTION DOB=0.501 L = 5.0. PSHOT PPLU X/90 .2421 .3632 .4843 .5484 .6053 .6465 .7264 FOUATTON COOR=0.201 L = 5.0. SHOT PPLU X/90 .4573 .5316 .6090 .6760	(R/RC) ± PLUF GLASS, 6CM FT PANGES LOG10 (X/PC515955190443986372913149276477218011766213883 (R/PC) = RPOWN GLAS FCH FT PANGES LOG10 (X/PC41896339782728416769 (R/PC) =	2 INCH 2 INCH R 17.054 17.054 13.311 10.333 7.778 5.105 3.149 2.042 1.512 1.295 .51F*(X/RC)** METEPS 31.640 4.2A7 3.191 1.341 .191*(X/RC)**	-2.164 CRATE R/RC 13.5478 8.2082 6.1792 4.0557 2.4964 1.6223 1.2010 1.2010 1.2010 1.2010 1.3	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.759 MFTERS ET RAMGFS LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .67806 .79731 .21812 .C77153 .01244 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS FT PANCES LOGIO(R/PC) 1.5047 .13492 .63180 .50407 .12758 CORRELATION COFFFICIENT	
EVENS GJUNE ELLET DEPTH ST SQ FIT T EVENS GJUNE ELLET DEPTH IELD DATA:	74 SLB, SI OF BURIAL WFTERS381457533 .610 .686 .752 .838914 C LOG-LOG 74: SLB, G C FRUPIAL	COUNTION DOB=0.501 = 5.01 E 5.01 FINOT PFLU	(R/RC) ± PLUF GLASS, 6CM FT PANGES LOGIO (X/PC5159551904439863729131497214811766213883 (R/PC)= RPOWN GLAS FC PANGES LOGIO (X/PC4189633978277842144411769 (R/PC)= OI REO AGRY(2 INCH 2 INCH R 17.054 17.054 13.311 10.333 7.778 5.105 3.149 2.042 1.512 1.295 .51F*(X/RC)** METEPS 31.640 4.2A7 3.191 1.341 .191*(X/RC)**	-2.164 CRATE R/RC 13.5478 8.2082 6.1792 4.0557 2.4964 1.6223 1.2010 1.2010 1.2010 1.2010 1.3	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.259 METERS ET RAMGFS LOG10 (P/PC) 1.13185 1.02423 .91425 .79093 .67806 .79731 .2112 .27153 .01744 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS FT RAMGES LOG10(R/PC) 1.50037 1.13492 .63180 .50407 .12758	= .9751
EVENS GJUNE ELLET DEPTH ST SQ FIT T EVENS GJUNE ELLET DEPTH IELD DATA:	74 5 8 SI OF BURIAL SI SI SI SI SI SI SI S	COUNTION DOB=0.501 L = 5.0. CSCOB=0.00 COUNTINE CSCOB=0.00 CSCOB=0.00 CSCOB=0.00 CSCOB=0.00 CSCOB=0.00 CSCOB=0.00 CSCOB=0.00 CSCOB=0.00 CSCOB=0.00	(R/RC) ± PLUF GLASS, 6CM FT RANGES LOG10(X/PC -51595 -51904 -47986 -37291 -31499 -76477 -21801 -17662 -13883 (R/PC)= RPOWN GLAS PCH -17 PANGES LOG10 (X/PC -41896 -21484 -16769 (R/PC)=	2 INCH 2 INCH R HEIFOR 17,054 13,311 10,333 7,778 5,105 1,142 2,042 1,512 1,512 1,512 1,512 1,512 1,512 1,512 1,514 1,144 1,14640 4,287 3,191 1,341 1,191*(X/RC)**	-2.164 CRATE RATE RATE 13.547? 10.5736 8.2082 6.2057 1.2010 1.0291 -2.4964 1.0291 -2.534 CRATE CRATE CRATE	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.259 METERS ET RAMGES LOGIO (P/PC) 1. 13185 1.02423 .91425 .79093 .67806 .79731 .2122 .C7353 .01244 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS FT PANCES LOGIO (R/PC) 1.50037 1.13492 .63180 .50407 .12758 CORRELATION COFFFICIENT	
ST SO FIT T EVENS GJUNE FULLO DATA: ST SO FIT T EVENS GJUNE FULLO DATA: ST SO FIT T	74 5 8 SI OF BURIAL SI SI SI SI SI SI SI S	COUNTION DOB=0.501 L = 5.0 FSHOT PPLU X/90 .2421 .3632 .4237 .4843 .5483 .5483 .6659 .7264 FOUATTON SOOR=0.201 X/RC .3611 .4573 .5316 .6098 .601ATICN SCOR=0.00 SCOR=0.00 SCOR=0.00 SCOR=0.00	(R/RC) ± PLUF GLASS, 50M FT RANGES LOG10 (X/PC	2 INCH 2 INCH RETERS 17,054 13,311 10,337 7,778 5,105 3,149 2,042 1,512 1,295 1,295 3,1641 17,640 4,287 3,191 1,341 4,191*(X/RC)**	-2.164 CRATF SHOT PFLL R/RC 13.5472 10.5773 8.2082 6.1792 4.0557 2.4964 1.6223 1.2010 1.0291 -2.534 CRATE SHOT L 9/HC 31.5493 4.2835 7.1921 1.7416 -5.315 CRATE SHOT PFLLI SHO	COPRFLATION COEFFICIENT R RADIUS (RC) = 1.259 MFTERS ET RAMGFT====================================	
ST SO FIT T EVENS GJUNE FULLO DATA: ST SO FIT T EVENS GJUNE FULLO DATA: ST SO FIT T	74:5LB, SI OF BURIAL X X MFTERS	COUNTION DOB=0.501 L = 5.0 FSHOT PPLU X/90 .2421 .3632 .4237 .4843 .5483 .5483 .6659 .7264 FOUATTON SOOR=0.201 X/RC .3611 .4573 .5316 .6098 .601ATICN SCOR=0.00 SCOR=0.00 SCOR=0.00 SCOR=0.00	(R/RC) ± PLUF GLASS, 6CM FT RANGES LOG10(X/PC -51595 -51904 -47986 -37291 -31499 -76477 -21801 -17662 -13883 (R/PC)= RPOWN GLAS PCH -17 PANGES LOG10 (X/PC -41896 -21484 -16769 (R/PC)=	2 INCH 2 INCH R HELERS 17.054 13.311 10.337 7.778 5.105 1.142 2.042 1.512 1.525 .51f*(X/RC)** MFTEDS 31.641 13.640 4.287 3.191 1.341 .191*(X/RC)**	-2.164 CRATF SHOT PFLL R/RC 13.5472 10.5773 8.2082 6.1792 4.0557 2.4964 1.6223 1.2010 1.0291 -2.534 CRATE SHOT L 9/HC 31.5493 4.2835 7.1921 1.7416 -5.315 CRATE SHOT PFLLI SHO	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.259 METERS ET RAMGES LOGIO (P/PC) 1. 13185 1.02423 .91425 .79093 .67806 .79731 .2122 .C7353 .01244 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS FT PANCES LOGIO (R/PC) 1.50037 1.13492 .63180 .50407 .12758 CORRELATION COFFFICIENT	9757
NEWENS GJUNE TELO DATAI ST SO FIT T TEVENS GJUNE TEVENS GJUNE	74:518, SI OF BURIAL X MFTERS .305 .381 .457 .453 .610 .686 .752 .630 .914 .C LOG-LOG .74: SLB,	COUNTION DOB=0.501 L = 5.0. PSHOT PPLU X/90 .3027 .3632 .4843 .5484 .6053 .6659 .7264 FOUATTON SDOR=0.201 L = 5.0. SHOT PPLU X/RC .3611 .4573 .5316 .6090 .6760 COUNTION SCOB=0.00 SCOB=0.00 COUNTION SCOB=0.00 SCO	(R/RC) ± PLUF GLASS, 6CM FT PANGES LOG10 (X/PC - 61595 - 61994 - 43986 - 37291 - 31492 - 76477 - 21891 - 17662 - 13883 (R/PC) = RROWN GLAS FCH FT PANGES LOG10 (X/PC) - 41896 - 233978 - 27284 - 16769 (R/PC) = URED AGRYG	2 INCH 2 INCH 2 INCH Reference 17,056 13,331 10,333 7,778 5,105 3,162 2,042 1,512 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,364 4,287 3,191 1,364 1,191*(X/RC)** Reference Ref	-2.164 CRATE RATE 13.5472 10.5738 8.2082 6.1792 4.0557 2.4.964 1.6223 1.2010 1.0293 1.0293 1	COPRFLATION COEFFICIENT R RADIUS(RC)=1.259 MFTERS ET RAMGET====================================	9757
ST SO FIT TO SEVENS GUNE	74 SLB, SI OF BURIAL X MFTERS, 381 -457 -533 -610 -610 -610 -74: SLB, G GF BUPIAL	COUNTION DOB=0.501 = 5.01 E 5.01 FSHOT PFLU	(R/RC)± PLUF GLASS, 5CM FT PANGES LOGIO (X/PC)5159551904439863729131492214811766213883 (R/PC)= RPOWN GLAS PCH TPANGES LOGIO (X/PC)4189633978277842148411749 (R/PC)= DI RED AGR Y(C)1010 (X/PC)11846511769117691176911769117691176911769117691176911769117691176911769117688	2 INCH 2 INCH RETERS 17,056 13,311 10,333 7,778 5,105 3,162 1,295 1,391 1,3640 1,	-2.164 CRATF SMOT PFLL R/RC 13.5472 8.2082 6.1792 4.0557 2.4964 1.6223 1.2010 1.0291 -2.534 CRATE SMOT LL 9/HC 31.6494 13.6433 5.1921 1.7415 -5.315 CRATE SHOT PFLL R/RC 7.5376	COPRFLATION COEFFICIENT R RADIUS(RC) = 1.259 METERS ET RANGES LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .67806 .79731 .21312 .07153 .01244 CORRELATION COEFFICIENT R RADIUS(RC) = 1.000 METERS FT RANGES LOGIO(R/PC) 1.50037 1.13492 .63180 .50407 .12758 CORRELATION COEFFICIENT R RADIUS(RC) = .527 METERS ET PANGES LOGIO(R/PC) .54071	9757
ST SO FIT T EVENS GJUNE FULLO DATA: ST SO FIT T EVENS GJUNE FULLO DATA: ST SO FIT T	74:518, SI OF BURIAL X MFTERS .305 .381 .457 .453 .610 .686 .752 .630 .914 .C LOG-LOG .74: SLB,	COUNTION DOB=0.501 L = 5.0. PSHOT PPLU X/90 .3027 .3632 .4843 .5484 .6053 .6659 .7264 FOUATTON SDOR=0.201 L = 5.0. SHOT PPLU X/RC .3611 .4573 .5316 .6090 .6760 COUNTION SCOB=0.00 SCOB=0.00 COUNTION SCOB=0.00 SCO	(R/RC) ± PLUF GLASS, 6CM FT PANGES LOG10 (X/PC 51595519044798637497218011766213883 (R/PC) = RROWN GLAS FCH FT PANGES LOG10 (X/PC)41896 (R/PC) = OI RED AGRY(CT FT PANGES LOG10 (X/PC) T PANGES LOG10 (X/PC) T PANGES LOG10 (X/PC)	2 INCH 2 INCH 2 INCH Reference 17,056 13,331 10,333 7,778 5,105 3,162 2,042 1,512 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,295 1,364 4,287 3,191 1,364 1,191*(X/RC)** Reference Ref	-2.164 CRATE RATE 13.5472 10.5738 8.2082 6.1792 4.0557 2.4.964 1.6223 1.2010 1.0293 1.0293 1	COPRFLATION COEFFICIENT R RADIUS(RC)=1.259 MFTERS ET RAMGES LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .6'806 .3731 .21912 .07193 .01244 CORRELATION COEFFICIENT R RADIUS(RC)=1.000 METERS FT PANGES LOGIO(R/PC) 1.5030 .50407 .12758 CORRELATION COEFFICIENT R RADIUS(RC)=2.527 METERS ET PANGES LOGIO(R/PC) .54671 .17659	9757
ST SO FIT T EVENS GJUNE FILET OCPTH ST SQ FIT T EVENS 19JUL EVENS 19JUL EVENS 19JUL	74 SLB, SI SI SI SI SI SI SI SI	COUNTION DOB=0.501 L = 5.0 PSHOT PPLU X/RC .3632 .3632 .483 .5483 .6659 .7264 FOUATTON SOOR=0.201 STORE .501 SHOT PFLU X/RC .4873 .698 .603 .603 .603 .603 .603 .603 .603 .603	(R/RC)± PLUF GLASS, 5CM FT PANGES LOGIO (X/PC)5159551904439863729131492214811766213883 (R/PC)= RPOWN GLAS PCH TPANGES LOGIO (X/PC)4189633978277842148411749 (R/PC)= DI RED AGR Y(C)1010 (X/PC)11846511769117691176911769117691176911769117691176911769117691176911769117688	2 INCH 2 INCH RETERS 17,056 13,311 10,333 7,778 5,105 3,162 1,295 1,391 1,3640 1,	CRATE SHOT PELL GRAC 13.5472 10.5738 8.2082 6.1792 4.0557 2.4964 1.6223 1.2010 1.0291 -2.534 CRATE SHOT L Q/RC 31.5494 13.5433 3.1921 1.7415 -5.315 CRATE GRAC T.5376 T.5376 1.5087	COPRFLATION COEFFICIENT R RADIUS(RC)=1.259 MFTERS ET RAMGES LOGIO (P/PC) 1.13185 1.02423 .91425 .79093 .6'806 .3731 .21912 .07193 .01244 CORRELATION COEFFICIENT R RADIUS(RC)=1.000 METERS FT PANGES LOGIO(R/PC) 1.5030 .50407 .12758 CORRELATION COEFFICIENT R RADIUS(RC)=2.527 METERS ET PANGES LOGIO(R/PC) .54671 .17659	= .9757

Table A2. Preshot and Postshot Distances of Individual Pellets (Cont)

PELLET DEPTH			ET RANGES	POST	SHOT PELL	ET RANGES		
PIELO DATAT	x	X/RC	LOGIO (X/PC) R	R/RC	LOGIO(R/RC)	-	
	METERS			HETERS				
	•25 4 •305	.4821 .5784	31668 23776	1.847 .860	3.5029 1.6301	.54443 .21220		
			-: n6176	.549	1.0405-	····· • 01723 ····		
L ST -SQ FIT T	o tog-tog	EOUATION	{ R/RC} =	.735*(X/PC) **	-1.907	CORRELATION	COEFFICIENT=	
DEVENS 19JUL	77413/8LB	, 5008≖8. 6	TRLY 1 THE	H	CRATE	R RADIUS (RC) =	1927 HETERS	
PELLET DEPTH			4 CH					
FIELO DATAL	Х Х	ESHOT PELL	ET RANGES LOGIO(X/PC		SHOT PELL R/SC	ET RANGES LCG10(R/RC)		
"	MFTFRS	*/**	COGIN (X)PI	HETERS	~, ~	CCOLOKKYRGY		
	.254	.4821	31688	1.789	3.3931	,53059		
	*305		+.2377K	.576	1.0925	.03842		
	•356	.6748	17085	.573	1.0867	.03611		
LST SQ FIT 1	C LOG-LOG	FOUATION	(P/PC)=	.230*(X/RC) **	- 4. 472	CORRELATION	COEFFICIENT=	.891
				*****		0011100-11201		

			51 004 NCC 44			D 04051101001		
PELLET DEPTH	OF 90874	, XLUF=0.2 L = 2.5	∵. U=4NGE AI 4(H	COAFIC + 1 INCH	UMAIL	P PAGIUS(PC)=	ADCC PETERS	
			FT RANGES	POST	SHOT PELL	ET PANGES		
FIELO DATA:	X	X/RC	LOGIC (X/FC	ρ .	R/RC	LOGIO(R/PC)		
	HFTERS	9		METERS	44	4 40		
. .	•152 •229	.2451 .3676	61866 43457	8.916 3.609	14.3235 5.8039	1.15605 .76372		
	.391	.6127	21272	• 963	1.5490	.19006		
ST SQ FIT T	O LOG-LOG	EQUATION	(R/RC)=	.481*(Y/PC)**	-2.434	CORRELATION	COFFFICIENT=	•999
EVENS 31JUL	77413/ELB	, SOOE=0.5	5: AL, 1 IN	CH C	CRATE	R RADIUS(RC) =	.622 HETERS	
ELLET DEPTH	OF SUPIA	L= 2.5	₽ CH					
	PP		T RANGES			FT RANGES		
TELO OATAT	METERS	Y/RC	LOGIO (X/FC	HETERS	R/RC	LOGIO (P/PC)		
	•229	.3676	43457	4.173	6.7108	. 82677		
	.305	.4902	30963	1.454	2.3382	.36889		
	.381	.6127	21272	1.017	1.6275	.21151		-
	.457	.7353	13354	, 738	1.1863	.07419		
ST SQ FIT T	0 L0G-L0G	EQUATION	(0/00)=	.499+(Y/RC) ++	-2.465	CORRELATION	COEFFICIENT=	.977
					•			
- TEWENS \$4.00	¥7111/4: 0	. 5008-0.2	51 BLUE GLAS		CDATE		. 22 HETERE	••
ELLET DEPTH				559 1 Imim	CKEIE	R RACIUS(RC) =	POSS MEIEKS	
			ET RANGES	POST	SHOT PFLL	ET PANGES		
TELO DATA:	¥	X/RC	LOS10 (X/RG)		R/RC	LOGIG(R/RC)		- · · · · ·
	HFTERS			METERS				
	.229 .305	.3676 .4902	43457	4,377	7.0392	.84752		
	305	.4902 :6127	30963 21272	1.606 ,777	2.5833 1.2500	•41218 • 8969 1		
				•••		4 0 34.37		
97 SO FIT T	0 LOG-LOG	EQUATION	(R/RC)*	.235*(Y/RC)**	-3.388	CORRELATION	COFFFICIENT=	.999
4								
# UF 18 ** ***	1/4 (3/ALP	, SCOE*0.?	o f HPOWN GLA	IZZ ⁴ S [ACH	CRATE	R RADIUS(RC) =	.622 HETERS	
EVENS 31JUL			T PANGES		SHOT EEL!	ET RANGES		
EVENS 31JUL PELLET DEPTH	PP				R/RC	LOGIO (R/RC)		
EVENS 31JUL PELLET DEPTH PIELD DATAI	**PP	X/RC	L06101X/PI					
ELLET DEPTH	Y HFTEPS	X/RC	COGIO(X/PC)	HETERS				
ELLET DEPTH	¥ HFTEPS •152	X/RC .2451	51856	451589 3.296	5.1569	,71239		
ELLET DEPTH	¥ HFTEPS •152 •229	2/85 .7451 .3676	-,61866 -,43457	4ETF49 3.296 2.405	3.8725	.58800		
TELET DEPTH	¥ HFTEPS •152	2/RC .7451 .3676 .4982	51856	451589 3.296	3.8725 1.8676	.56800 .27129		٠
TELET DEPTH TELO DATAI 	¥ HFTEPS •152 •279 •705 •781	x/RC .7451 .3676 .4982 .6127	-,61866 -,43457 -,70963 -,21772	457509 3.296 2.404 1.151 .744	3.8725 1.8676 1.1961	.58800		•
TELET DEPTH	¥ HFTEPS •152 •279 •705 •781	x/RC .7451 .3676 .4982 .6127	-,61866 -,43457 -,70963 -,21772	457599 3.296 2.404 1.161	3.8725 1.8676 1.1961	.58800 .27129 .07776	COEFFICIENT=	967
TELET DEPTH TELO DATAI 	¥ HFTEPS •152 •279 •705 •781	x/RC .7451 .3676 .4982 .6127	-,61866 -,43457 -,70963 -,21772	457509 3.296 2.404 1.151 .744	3.8725 1.8676 1.1961	.58800 .27129 .07776	COEFFICIENT=	. 967
TELET DEPTH TELO DATAI 	Y HFTEPS -152 -705 -781 0 LOG-LOG	x/RC .7451 .3676 .4982 .6127	-,61866 -,43457 -,70963 -,21772	457509 3.296 2.404 1.151 .744	3.8725 1.8676 1.1961	.58800 .27129 .07776		
TELLET DEPTH	Y HFTEPS -152 -279 -705 -781 0 LOG-LOG	X/RC .7451 .3576 .4912 .6127 EQUATION	61066 43457 30963 21777 (P/RG)=	46TFQQ 3.206 2.409 1.161 .744 .592*(X/QG)**	3.8725 1.8675 1.1961 -1.634	.58A00 .27129 .07776 CORRELATION		
TELLET DEPTH	Y HFTEPS .152 .705 .781 U LOG-LOG Y7413/6LR OF SURTAL	x/RC .2451 .3676 .4982 .6127 EOUATION .5008=0.2	61066 43457 30963 21272 (P/RC)=	METERS 3.206 2.403 1.161 .744 .592*(X/QC)**	3.8725 1.8675 1.1961 -1.634	.58800 .27129 .07776		
TELO DATAL TELO DATAL ST SQ FIT T EVENS 31JUL ELLET DEPTH	Y HFTEPS -152 -279 -105 -181 U LOG-LOG 	X/RC .7451 .3676 .4917 .6127 EOUATICN .5108*0.2 L * 5.8 ESHOT PELL	61066 43457 30963 21777 (P/RC)=	METFOR 3,276 2,403 1,161 ,744 ,592*(X/QC)**	3.8725 1.8676 1.1961 -1.634 CRATE	.56A00 .27129 .07776 CORRELATION R RADIUS(PC) =		
TELLET DEPTH	Y HFTEPS .152 .279 .105 .181 0 LOG-LOG Y7413/6LR OF SURIA	X/RC .7451 .3676 .4917 .6127 EOUATICN .5108*0.2 L * 5.8 ESHOT PELL	61066 43457 30963 21272 (P/RC)=	NETFOC 3.206 2.403 1.161 .744 .592*(X/QC)**	3.8725 1.8676 1.1961 -1.634 CRATE	.58A00 .27129 .07776 CORRELATION		
TELO DATAL TELO DATAL ST SQ FIT T EVENS 31JUL ELLET DEPTH	Y HFTEPS .152 .279 .705 .781 O LOG-LOG Y7413/6LR OF BURTAL THEFERS	X/RC .7451 .3676 .4902 .6127 EOUATICN . S708=0.2' L = 5.6 ESHOT PELLI X/RC	-,61066 -,43457 -,30463 -,21272 (P/RC)= F1 AL, 2 ING BCM F1 RANGES LGG10 (X/PC)	METERS 3,276 3,276 2,403 1,161 ,744 ,592*(X/PG)**	3.8725 1.8676 1.1961 -1.634 CRATE	.58A00 .27129 .07776 COFRELATION R RADIUS(RC) = ET RANGES LOGIO(R/RC)		
TELO DATAL TELO DATAL ST SQ FIT T EVENS 31JUL ELLET DEPTH	Y HFTEPS .152 .279 .105 .181 0 LOG-LOG Y7413/6LR OF SURIA	X/RC .2451 .3676 .4982 .6127 EOUATICN .508*0.2' L # 5.6 ESHOT PELL X/RC .2451	61066 43457 70963 21777 (P/RG)= fi AL, 2 ING BCM FI RANGES LGG10(X/PC)	HETERQ 3.216 2.405 1.161 .744 .592*(X/QC)**	3.8725 1.8676 1.1961 -1.634 CRATE: SHOT PELL: R/RC 5.6765	.58A00 .27129 .07776 COFRELATION R RADIUS(RC) = ET RANGES LOGIO(R/RC) .75508	.622 HETERS	
TELO DATAL TELO DATAL ST SQ FIT T EVENS 31JUL ELLET DEPTH	Y HFTEPS .152 .279 .T05 .T81 U LOG-LOG Y7413/6LR OF BURTAR TETERS HETERS	X/RC .7451 .3676 .4902 .6127 EOUATICN . S708=0.2' L = 5.6 ESHOT PELLI X/RC	-,61066 -,43457 -,30463 -,21272 (P/RC)= F1 AL, 2 ING BCM F1 RANGES LGG10 (X/PC)	METERS 3,276 3,276 2,403 1,161 ,744 ,592*(X/PG)**	3.8725 1.8676 1.1961 -1.634 CRATE	.58A00 .27129 .07776 COFRELATION R RADIUS(RC) = ET RANGES LOGIO(R/RC)		

Table A2. Preshot and Postshot Distances of Individual Pellets (Cont)

PELLET DEPTH			T RANGES		SHOT PELL	ET RANGES	· · · · - ·	
FIELD DATAL	X	X/RC	LOGIO (X/PC)	R	R/RC	LOG16(R/RC)		
	HETERS	. 2451	61066	3,719	5.9804	.77673		
	•152 •229	.3676	43457	2.371	3.8137	.98139		
	.305	.4992	30963	1.173	1.6873	.27583		
	.361	.6127	21272	.685	1.1029	. 84255	-	
LST 50 PIT T	0 L0G-L0G	EQUATION -	(#/RG)=: "	.491*(X/#C)**	+1.857	- CORRELATION	COEFFICIENT=	.9820
BEVENS 185EP PELLET DEPTH	1741 1 LB	C4, \$708=1	0.80, AL 1 1	INCH	CRATE	R RACIUS(RC) =	.658 HETERS	· · - · · · · ·
		SHCT FELL	T RANGES			FT WANGES		
FIELO DATAL	X HFTERS	X/RC	LOGIO (X/FC)	METERS	R/RC	LUGIUNIA		
	.229	.3472	45939	13,692	20.7963	1.31799		
-	.365	.4638	33445	4.697	7.1343	.85335		•
	.361	.5747	23754	2.475	3.7593	.57510 		
	··	.6994	158**	.991	119846			
134 30 FIT T	C LOG-LOG	EOUATION	(P /RC)=	.433* {X/PC}**	-3.679	CORRELATIO	· COEFFICIENT="	
ė								
EVENS 10SEP	OF BURIAL	. = 7.50	i The			R RADIUS (RC) =	,713 HETSHS	•••
ETE: 0 0474;	PR{		T RANGES Log10(X/FC)		SHOT PELL R/RC	ET PANGES LOG10(P/PC)		
FIELD DATA:	METERS	-/**		HETEPS	47 RU	C0010(k)=0)		
	•550	. 3215	49415	35.616	49.9359	1.69841		-
	.305	. 4274	-,36922	13.262	18.5940	1.26937		
	.381	.5342	27231	5,273	7.3932	. 86883		
	.457 .533	.6418 .7479	19317 17f18	2.245 .930	3.149F 1.3034	.49825 .11588		
LST 50 FIT T	.0 F00+F00	ECUATION	(8\vC)=	.445*(X/PC)**	-4.265	COPRELATION	COEFFICIENT*	.9952
	•							
DEVENS 105EF PELLET DEPTH	OF BURIAL	. = 7.6	PCM			R RADIUS (RC) =	.713 HETERS	
FIELD DATAL		SHOT PELLI X/RC	ZAVGES (SAVX)01001		SHOT PELL R/RC	ET R#NGES LOG10(R/PG)		
	HETERS			METERS				
	.152	.7137	67025	5.014	2.8291	.45164		
	.553	.3265	49415	3,667	5.1410	.71105	•	-
	.305	.4274 .5342	36922	1.143	1.6026	.20482		
	.381 .457	.6410	27231 19312	1.189	1.1410	.21850 .05730		
LST SO FIT T	0 LOG-LOG	EQUATION	(R/RC) =	.842*(X/PC)**	-1.009	CORRELATIO	GOFFFIGIENT=	.7422
DEVENS 185EF PELLET DEPTH	TOF BURTA	7.51	CH			R RADIUS(RC):	.841 HETERS	
P1610 04141	PR	ESHOT PELLI X/RC	FT RANGES LOG10(Y/RC)		SHOT PFLE	.ET PANGES LOG10(R/#C)		
	HETEPS			METERS	~, ~,	-0010101001		
. •	.229	.2717	56585	32.044	38.0906	1.58082		
	.305	.3623	44091	29.276	34.8007	1.54159		
	381	.4579	79400	17.661	16.5000	1.21748		·
	+457	. 5435	26482	6.559	7.7971	. 291 97		
	.533	.6341	19787	7.286	3.9058	.59171 .31114		
	.610 .686	.7246 .8152	1398# 98873	1.722	2.0471 1.1630	.06560		
LST 30 717 1	10 LOG-10G	FOURTICH	(R/PC)=	.797* (Y/PC)**	-3.374	CORRFI ATTO	COEFFICIENT=	. 9882
DEVENS 105FF PELLET DEPTH	OF WINIA	L t 7.67	PPH			R RACIUS(RC)	41 METERS	
#9#1 B ALT.			T RANGES			FT RANGES		
FIELD DATA:	Y HE TERS	YZZ	fucto (XVac.	D Meters	K/ RC	LOG10(9/9C)		
	15154	.7717	56585	17,509	14.8696	1.17230		
	105	. 1621	44091	1.784	11.6304	1.06560		
	. 38 1	. 4529	46440	4.445	5.5717	. 74208		• • • • • • • • • • • • • • • • • • • •
	.457	.5415	26482	1.921	> 5856	. 3584.7		
	.533	. 6341	19787	1,317	1.5652	.19457		
	TO LOG-LOG	COURTION	(P/RC)+	.472*(X/PC)**	-2.847	CORREL AT TO	COFFFICIENT=	

Table A2. Preshot and Postshot Distances of Individual Pellets (Cont)

				~~POST			
FIELD DATA:	X NETERS	X/RC	LOG10(X/RC)	R Weters	R/RC'	LOG18(R/RG)	
	.305	.3623	44091	2.481	2.9493	,46972	
		4529	34700	1.524	1.8116	25806	
	.457	.5435	26482	1.244	1.4783	•16975	
LST SQ FIT TO	L0G-L0G	EQUATION	(R/RC)=	.498*(X/RC)++	-1.721	CORRELATION COEFFICIENT	r= .984
DE VENS 18SEPT				INCH	CRATE	P RADIUS(RC)= .799 HETERS	
PELLET DEPTH	אנאטם זט קל-∸	ESHOT PELL	FT PANGES	POST	SHOT PELL	ET RANGES	
PIELD DATAL		X/RC	LOGIOCX/PC)	P	R/RC	LOGIOTR/RC1	
· · ·	HETFRS .229	,2863	54324	METERS 25.771	37.2710	1.49881	
	.305	.3817	41630	8.662	10.8473	1.03532	
	.301	.4771	32139	4.011	5.0229	.70895	
	•457 • 933 -	•5725 •6679	24221 17776	2.350	7,9427	.46875 	
.47 44 517 74	•						
LST 50 FIT TO	100-100	EQUAL TON	(R/RC)=	++{\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	-3.429	CORRELATION COEFFICIENT	'= " ,999
DEVENS 10SEPT	741 1 L8	C47 S008=	0.375, AL T	INCH	CRATE	R RADIUS (RG) = .799 HETERS	
PELLET DEPTH	OF BURIA	. = 7,6	SCM	•			
FIELD DATA:	PR(+T RANGES Logio(x/PC)	₽	SHOT PFLL R/RC	ET PANGES LOG10(R/RC)	
	METERS			METER S			
	.229	.2863	-,54324	2.871	3,5954	.55575	
	305 -	3817 .4771	41830 32139	2.348	3.0000 2.1947	47712	
- · ·	.457	.5725	?4221	1.259	1.5763	.34137 .19765	
LST SQ FIT TO	r ~->= t06	ECUATION	(9/°C) =	.875* (x/9C) **	-1.182	CORRELATION COEFFICIENT	= .974
			• • •				
DEVENS 25SEPT	741588 GI	C41 STOR		I MC F	CRATE	R RADIUS (PC) = .652 HETERS	
PERCEI OCPIN	PRE	SHOT FELL	T PANGE	P0ST	SHOT PELL	FT WANGES	
FIELD DATAS	×		LOG 10 (X/PC)	R	R/RC	LOG10 (P /PC)	
	FTERS •229	. 45 65	- 45575	HETERS	44 3535		
	.305	.4673	45535 33041	7.666 3.031	11.7523 5.8738	1.07012 .76892	
_	.381	.5841	23750	1.881	2.8832	.45987	
	.457	.7809	15432	. 759	1.1636	.06579	
LST 50 FIT TO	LOG-LOG	EQUATION	(P/RC)=	. 6200(X/OC) **	-3.267	CORRELATION GOEFFICIENT	.9864
•							
DEVENS 25SEPT	741 508 (H CAT SINCE	**0.00. AL 2	THEH	CRATE	R RACIUS(RC) = .652 METERS	***
PELLET DEPTH (F BURTAL	¥ 5.86	S CH				
PIELO DATA:	×	374 1 PELLE 1814	T RANGES LOGIT(X/PC)			ET PANGES Logio(P/PS)	
	ETERS		Ç Ç. 1 4 7 1 - 1 7	HETERS	17-4	50010(11)-21	
	.254	. 3505	45535	1.289	1.9768	. 29593	
	.305 .781	.4673 .5841	73041 73750	1.317 .869	2.0187 1.3318	.30507 .12463	
LST 50 FIT TO							
631 34 717 10			{R/RC}=	** (79\x) *E &e.	-,/35	CORRELATION COFFFICIENT	• .6013
9EVENS 253 EP TI			95A. 98. AL 1	1454	CDATE	R PACIUS(RC) = .759 MFTERS	
PELLET DEPTH	F BURTAL	. = 2.54	· CH				
em. n. e		SHOT PELLI	T PANGES	PQST		FT RANGES	
FIELD DATA!	Y FFERS:	X/ &C	LOGIO(X/PC)	D WFTFDC	R/AC	LOGIO (R/PC)	
•	.305	.4016	19670	11.655	17,9920	1.25508	
	. 381	.5820	29929	9.000	11.9639	1.07767	
	.457	.6024 .7026	77011 14716	2.441 1.423	1.7430 1.8755	.52572, 51655,	
131-30-717-70	£05~£0#	EGUSTICH	(P/4^) z	. #64# (YYPC) **	-4.787	COSPECATION COMPPECTENT	v, 4746
BEVENS 253EPT: PELLET BEPTH (INCH	CRATE	RESTANCES 140 HETERS	
		SHOT PELLE	T BANGES			FT RANGES	
FIELD DATA:	Y FTERS	X/DC	FUCTSEXABUT	P HFTEDS	R/RC	LOGIGIPARCI	
	.229	.3012	-,52114	9.261	12.2046	1.08651	
		.4016	-, 39620	F. 184	9. 4659	.47616	
	.305		-4 34450				
	. 381	.5820	79979	3.045	4.0120	.60337	
k ar sa 727 To	.381 .497	.5820 1 9924	79979 22911		4.0120 2.0187		٠.

Table A2. Preshot and Postshot Distances of Individual Pellets (Cont)

DEVENS 25SEF	T OF BURI	tt = 7.4	52 CM		•	R PADIUS (RC)= .759 HETERS	
	PF		LET RANGES		SHOT PEL	LET PANGES	
FIELD DATAS	x		LOGIOLY/PC			LOGIO (P/RC)	
	HETERS			METERS			
•	.229	.3012	57114	1.926	2.5382	.48452	
	.305	.4015	39620	1.798			
	187	5021	29929				
	.457	•6024	22011	.844	1.1124		
L <u>s</u> t sq fit t	C LOG-100	EGLATION	(P/9C)=	*#04* . */ RG)**	-1.063	CORRELATION COEFFICIENTS	.8412
	_						
DEVENS 25SEP PELLET DEPTH	ON MONTE	N = 1-1	16.24			PADIUS (PC) = .466 MFTERS	
	PR	RESHOT PELI	LFT RANGES	POST			
FIELD DATA:	X METERS		LOGIPITALE	METERS	R/RC	LOG10(P/PC)	
			45132		17.2887	1.23776	
	. 38 1						
	J457	.5292	35641 27727	5,475			
	.531	.6167	21928	2,615		.46017	
	.610						
.57 SQ FIT T	0 toG-LOG	EPUATION	(P/9C) =	.538*(X/RC)**	- 3, 453	COFRETATION CREFFICIERTS	- 4829
DEVENS 29SEP	1741 580	GH CAT SOC	18:0.54, AL,	T INCH	CRATE	P RADIUS (PC)= .A66 METERS	*****
DEVENS #98EP PELLET DEPTH	OF MURIA	L = 7.5	25 Cm			PRESTRICT AND TEST OF PROPERTY OF THE PROPERTY	
PELLET DEPTH	OF MURIA	IL = 7.F P esmot peli	SZCH "IT RANGES	POST	SMOT PFLI	P RADIUS(PC)= .A66 METERS	
PELLET DEPTH	OF MURIA PR X	IL = 7.5 ESHOT PELI Y/AC	25 Cm	POST	SMOT PFLI	PRESTRICT AND TEST OF PROPERTY OF THE PROPERTY	
PELLET DEPTH	OF MURIA ************************************	IL = 7.5 ESHOT PELI Y/RC	PERMITTERS (C)	PQST R HETERS	SMOT PELL 9/90	P RADIUS(RC) = .A66 HETERS ET PANGE LOGIUNIO)	
PELLET DEPTH	OF MURIA X HETERS .229	IL = 7.6 ESHOT PELI X/AC .7661		POST R METERS 17.160	SHOT PFLL 9/80 19.8239	P RADIUS(RC)= .864 METERS FT PANGES L0610(R/PC) 1.29719	
PELLET DEPTH	OF MURIA X HETERS .229	IL = 7.6 ESHOT PELI X/AC .7661		POST R METERS 17.160 5.782	SHOT PFLI 9/80 19.8239 6.6444	P RADIUS(PC) = .A66 METERS ET PANGES LOGIO (R/PC) 1.29719 .82245	
PELLET DEPTH	OF MURIA ************************************	: 7.6 ESHOT PELL X/AC .7641 .3521 .4401	.7 RANGES tog 19(x/PC) 57876 45332 35641	POST RETERS 17.160 5.742 5.002	SHOT PFLI 9/80 19.8239 6.6444 5.7782	P RADIUS(RG)= .866 METERS FT PANGET LOGIO(R/PG) 1.29719 .82245 .76179	
PELLET DEPTH	OF MURIA ************************************	.7641 .7641 .3521 .4401	.7CH .IT RANGES LOG17(X/PC: 57876 45332 35541 27773	POST) METE PS 17.160 5.747 5.002 7.257	SHOT PFLI 9/80 19.8239 6.6444	P RADIUS(PC) = .866 METERS .ET PANGES	-
FIELD MATA:	OF MURIA ************************************	. 7.6 ESHOT PELL X/AC . 7641 . 3521 . 4401 . 7787 . 6162	2 CM IT RANGES LOG 19 LX/P C: 	POST) METE PS 17.160 5.747 5.002 7.257	5HOT PFLI 9/RC 19.A239 6.6444 5.7782 7.7577 1.8908	P RADIUS(RC) = .866 METERS ET PANGES LOGIO (R/PC) 1.29719 .82765 .76179 .57685	
FIELD PATAL ST SQ FIT T	OF MURIA	L = 7,6 ESHOT PELL X/RC .7661 .3521 .4601 .7588 .6162 .60471CH	17 RANGES 10 G19 (X/OC) 57826 45332 35441 27773 21028 (R/PC)=	P METE PC 17.160 C.740 5.002 7.252 1.637	SHOT FFLI 9/RC 19.A239 6.6444 5.7782 3.7570 1.8908 -2.507	P RADIUS(RC)+ .A66 METERS .FT PANGFS LNG18(R/PC) 1.29719 .R2785 .76179 .57885 .27866	
FIELD MATA:	OF BURIA OF BURIA OF BURIA	L = 7,6 ESHOT PELL X/RC .7661 .3521 .4401 .7277 .6162 .EOUATICH	17 RANGES 10G191X/PC: 57826 65132 35541 27727 21028 (R/PC)=	P R METERS 17.160 17.160 17.160 17.767 17.57 1.637 1.637	SHOT PFLL 9/RC 19.A239 6.5644 5.7782 7.7577 1.8908 -2.507	P RADIUS(RC)= .A66 METERS FT PAMSFC LOGIU(R/PC) 1.29719 .R2265 .76179 .57686 CORPFLATION COEFFICIENT=	
FIELD PATAT	OF BURIA OF BURIA OF BURIA	L = 7.6 ESHOT PEL X/AC .7641 .3521 .4401 .5282 .6162 .600ATICH GH CAT SIGN GH	.2CW .1T RANGES1T RANGES4578264573235642772321028 (R/PC)= .0=0.50, 4L, 6CM LT PANGES	POST	SHOT PFLL 9/80 19.4239 6.5444 5.7782 3.7577 1.8908 -2.507 CPATE	P RADIUS(RC) = .A66 METERS FT PANGES LOGIO(PPC) 1.29719 .R2PA5 .76179 .578P5 .276A6 CORPFLATION COEFFICIENT=	
FIELD PATAT		L = 7.6 PESHOT PER 3781 3781 4401 3787 6167 EQUATION L = 10.1 ESHOT FILL X/80	17 RANGES 10G191X/PC: 57826 65132 35541 27727 21028 (R/PC)=	POST	SHOT PFLL 9/80 19.4239 6.5444 5.7782 3.7577 1.8908 -2.507 CPATE	P RADIUS(RC)= .A66 METERS FT PAMSFC LOGIU(R/PC) 1.29719 .R2265 .76179 .57686 CORPFLATION COEFFICIENT=	
FIELD PATAT	HETERS 229 305 371 387 533 C LOG-LOG TPA: 500 OF BURIA HETERS	L = 7.6 PESHOT PER 3781 3781 4401 3787 6167 EQUATION L = 10.1 ESHOT FILL X/80	.7CM .1T RANGES1578265578265578265578262772321028 (R/PC)= .000,50, 4L, .0010 (N/PC)=		\$\$\text{\$\tex{\$\text{\$\e	P RADIUS(RC)+ .A66 METERS FT PANGES LOGIU(R/PC) 1.29719 .R2945 .76179 .576.R5 .27666 CORPFLATION COEFFICIENT= R PACIUS(RC)= .466 METERS FT PANGES LOGIO(P/PC)	
PELLET DEPTH FIELD MATAL LST SQ FIT T	HETERS 229 305 381 387 533 C LOG-LOG T7A; 500 OF BURIA	L = 7.6 ESHOT PEL X/RC .7661 .3521 .4601 .7282 .6162 .60162 .60171CH GH Cat Snot L = 10.1 ESHCT FELL X/RC .7641	17 RANGES 10 RA		SMOT PFLL 9/80 19.8239 6.5644 5.7782 7.7577 1.8908 -2.507 CPATE SMOT PFLL 4/80 9.9848	P RADIUS(RC)= .A66 METERS ET PANGES LOGIO (R/PC) 1.29719 .82745 .76179 .57685 .27666 CORPFLATION GOEFFICIENT= R PAGIUS(RC)= .866 METERS FT PANGES LOGIO(P/PC) .59847	
FIELD PATAT	TTA: SOO OF BURIA NETTRS 229 305 374 533 C LOG-LOG TTA: SOO OF BURIA	L = 7.6 ESHOT PELL X/RC .7661 .3921 .4001 .7587 .6162 .600413CH GH C4: Sno L = 10.1 ESHCT FFEL X/RC .7691 .3521	17 RANGES 10619(X/OC) 57826 55132 15641 27723 21028 (R/PC)= 000.50, 4L, ACM LT PANGES LOGIB (Y/PC) 45132	P HETE PR 17.160 17.160 17.160 17.160 17.257 1.637 1.6	SMOT PFLL 9/RC 19.8239 4.5444 5.7787 1.8908 -2.507 CPATE SMOT PFLL 4/RC 9.4648 4.3569	P RADIUS(PC)= .A66 METERS ET PAMSTS LOGIO(PAPC) 1.29719 .82265 .76179 .57686 CORPFLATION COEFFICIENT= R PADIUS(RC)= .866 METERS FT PAMSES LOGIO(PAPC) .98857 .72895	
FIELD PATAT	OF MURIA	L = 7.6 ESHOT PELL X/RC .7661 .3921 .4001 .7587 .6162 .600413CH GH C4: Sno L = 10.1 ESHCT FFEL X/RC .7691 .3521	17 RANGES LOG10(X/OC) 57826 55332 35641 27723 21028 (R/PC)= (R/PC)= (R/PC)= (UT PANGES LOG18(X/PC) 55332 55332 55327 55327 55327 55327 55327 55327 55327	POST: PO	SMOT PFLL 9/RC 19.8239 4.5446 5.7782 3.7577 1.8908 -2.507 CPATE SMOT PFLL 4/RC 9.4648 4.3597 3.6351 3.6353	P RADIUS(RC) = .A66 METERS ET PANGES LOGIO(R/PC) 1.29719 .82265 .76179 .57685 .27666 CORDELATION COEFFICIENT= R PADUUS(RC) = .866 METERS FT PANGES LOGIO(R/PC) .98847 .7295 .91846	
FIELD PATAL ST SO FIT T EVENS 25SEP ELLET DEPTH	TAL SOO OF BURIANTERS 1774: 500 OF BURIANTERS 1279 1774: 500 OF BURIANTERS 1774 1774 1774 1774 1774 1774 1774 177	L = 7.6 ESHOT PELL X/RC .7661 .3921 .4001 .7878 .6162 .600413CH GH C4: Sno L = 10.1 ESHCT FFEL X/RC .7641 .3521	17 RANGES 10 RA		SMOT PFLL 9/RC 19.8239 4.5446 5.7782 7.7577 1.9908 -2.507 CPATE SMOT PFLL 4/RC 9.4648 4.3597 3.8351	P RADIUS(PC) = .A66 METERS ET PAMSFS LOGIO (R/PC) 1.29719 .87245 .76179 .57646 CORPFLATION GOEFFICIENT= R PANGES LOGIO(P/PC) .98847 .7295 .9164	